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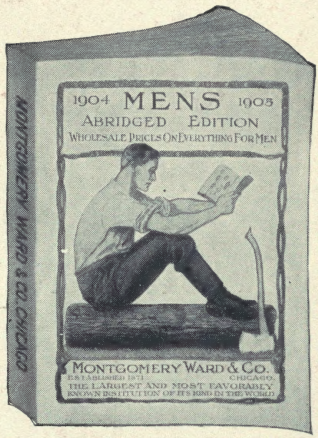
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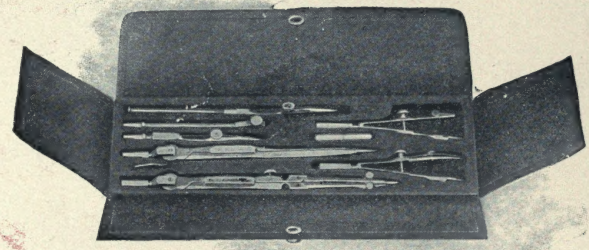

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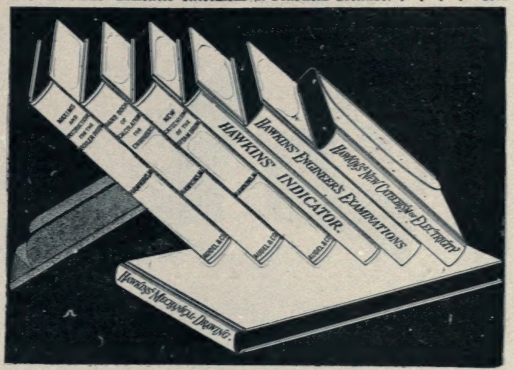

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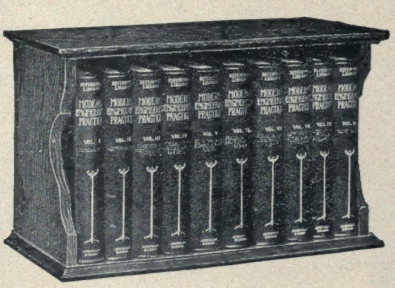

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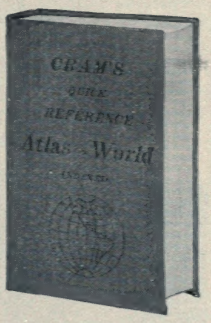

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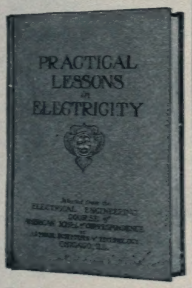

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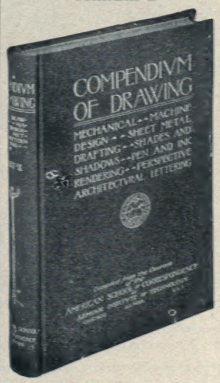

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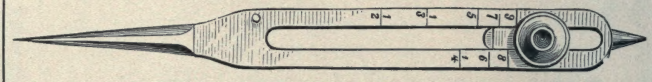

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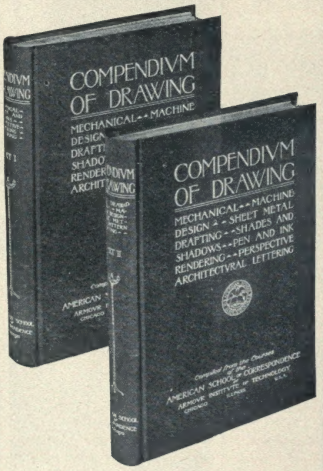
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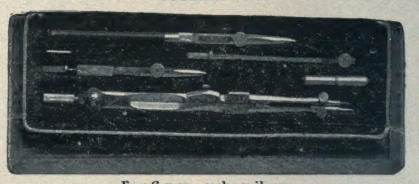

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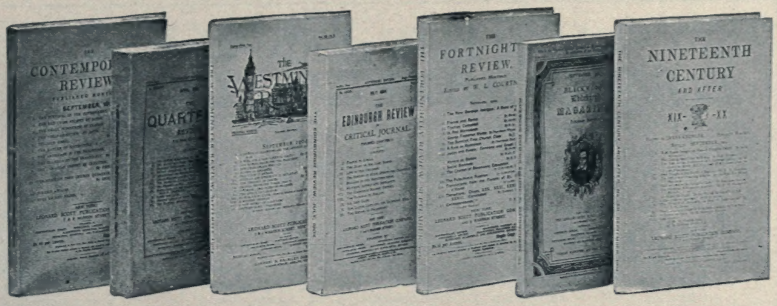

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matters of live interest bearing on the world's technical progress. Some of the foremost technical writers of the day have been secured as contributors; and facilities for securing first-hand accounts of actual developments as they arise, have been greatly extended. Neither money nor effort will be spared to keep THE TECHNICAL WORLD the foremost magazine of its class.

INDUSTRY AND COMMERCE, LIFE STORIES OF SUC-
TECHNICAL BOOK REVIEWS, ETC.

that may be looked for in the near future

Electro-Horticulture
By JOHN ELFRETH WATKINS.

The forcing of plant growth and germination by means of electricity. A portrayal of the new lines of research to be undertaken by the U. S. Department of Agriculture, accompanied with a review of other experiments in Europe and elsewhere. Fully illustrated.

The World's Greatest Shipyard
By WINTHROP PACKARD.

A descriptive account of the great yard of Harland & Wolff, Belfast, Ireland, where the largest ships the world has seen have been built. Including sketch of the interesting career of the head of the firm, a Canadian-born lad who entered their employ as a mechanic at the age of fifteen.

(OVER)

THE TECHNICAL

(*Continued from preceding page*)

How Eclipses are Predicted

By Prof. David P. Todd, Director of Amherst College Observatory, Amherst, Mass.; Author of "Stars and Telescopes," etc.

A total eclipse of the sun, visible in part of North America, will occur on August 30. A month before the event, Professor Todd will tell our readers, in a general way, how these interesting occurrences are predicted, throwing as much light upon the mystery as can be borne by the general reader unaccustomed to ethereal flight in the region of higher mathematics.

Pioneer Climbing in a New Switzerland

By Prof. Charles E. Fay, of Tufts College, Massachusetts, First President of the American Alpine Club.

On our own continent, in the Rockies and Selkirks, is found an Alpine world vaster in area and no less impressive in grandeur than that of Switzerland. Professor Fay is a regular visitor to this region, and an ardent and experienced climber. In this article he describes the region and relates some of his unique experiences. Illustrated with many magnificent views.

Wireless Telephony

By A. Frederick Collins, Author of "Wireless Telephony: Its History, Theory, and Practice."

All the mystery of sending telephone messages without the use of wires, clearly explained in easily comprehended language. Finely illustrated with photographs of apparatus, and explanatory diagrams.

Tornadoes

By J. E. Watkins

A descriptive article of surpassing interest. Theories of tornadoes and other storms explained. Historic instances of their destructive work related, illustrated with a unique collection of photographs of actual tornadoes specially secured for The Technical World.

Photography for Amateurs

By Louis A. Lamb, Editor *Pit and Post*.

A series of articles constituting a practical course in photography. The mechanism of the camera; selection of cameras for various kinds of work, plates, films, etc.; choice and handling of subjects, position, light, exposure, etc.; finishing of photographs, papers, masking, vignetting, inserting clouds, prints for half-tones; interiors, flash-light, groups, etc.

Navy, Army, and Ordnance

A series of articles, each by an expert, on the U. S. Torpedo-Boat Flotilla, Manufacture of Ordnance, Naval Proving Grounds, War Balloons, Target Practice in the Army, etc.

The Panama Canal

Arrangements are being made to keep the readers of The Technical World in touch with the latest developments in connection with the engineering problems involved in building the great isthmian waterway which will double the efficiency of the American Navy and the mercantile marine of the world.

WORLD FOR 1905

Mississippi River Levee System

By JUDGE R. S. TAYLOR, formerly Member of the Government Levee Commission.

In confining the waters of the lower Mississippi, vast sums have already been spent; but the final solution of the problem is still a heritage of the future. The nature of the engineering problem; the results accomplished; their significance for the agricultural and industrial interests of the States along both banks—these and other features graphically described and abundantly illustrated.

The Industrial Side of Copper

By W. R. STEWART.

A descriptive account of Mining and Smelting operations as conducted at some of the great mines and plants of the country. The picturesque features, as well as commercial importance, of this great technical industry fully set forth. Abundantly illustrated.

Production and Uses of Compressed Air

By A. E. CHODZKO, Consulting Engineer.

The industrial applications of compressed air have been in some respects revolutionary. It is used to run locomotives, work pneumatic tools of all kinds, clean houses, etc. The mechanism of air-compressors, the principles of their action, the uses of their output, etc., are clearly and entertainingly set forth and illustrated.

The Manufacture of Ice

By OSWALD GUETH, M. E.

Methods of mechanical refrigeration popularly explained. Development of the industry of ice-making. The varied possibilities of its application to commercial uses, the functions of social amusement, etc. Abundantly illustrated.

Forest Fires

By J. E. WATKINS.

The destruction of some of the richest resources of our country by forest fires has permanently devastated certain regions and wrought irreparable damage in others, besides having far-reaching effects on climate, water-supply, etc. Methods of prevention and fighting of fires are here shown—illustrated with numerous photos of fires raging, fire lanes constructed, ruins of towns and forests involved, etc. An article of absorbing interest to everyone.

Industrial Value of Small Streams

By GEORGE ETHELBERT WALSH.

An exhaustive treatment of a topic of great importance. Increasing attention is being drawn to the forces of nature within our reach but hitherto unavailed of for practical uses. The value of the waste power embodied in the many small streams in all parts of the country, its possible application to the generation of mechanical and electrical energy, and other points in this connection, are brought out and fully illustrated.

"Raffles"

Amateur Cracksman

will make his reappearance in

Collier's

the periodical which last year brought Sherlock Holmes back to life.

The first of the new adventures, "Out of Paradise," will appear in the December 10th number.

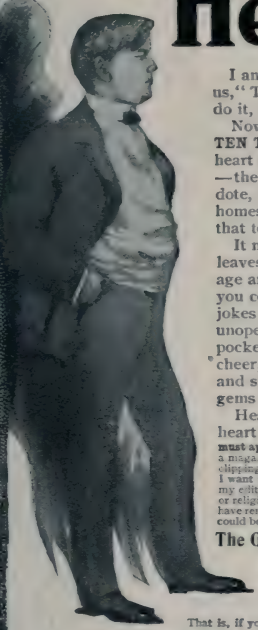
At all news stands for an entire month, ten cents.

STORIES TO BE PUBLISHED

1. "Out of Paradise," December 10th
2. "The Chest of Silver," January 21st
3. "The Rest Cure," February 25th

Mention The Technical World.

I will give $10,000 for Heart Throbs



I am editing "The National Magazine" for what Lincoln loved to call us, "The plain people of America." President McKinley told me I could do it, and the magazine has been a success beyond all expectations.

Now, I want you to help me edit The National, and I am going to give **TEN THOUSAND DOLLARS** to those who will do it. What I want is real heart throbs—those things that make us all kin; those things that endure—the classics of our own lives. Send me a clipping, a story, an anecdote, or a selection that has touched your heart. It is in the American homes that I am searching for the literature that endures—those things that touch and pulsate with the best and noblest emotions and sentiment.

It may be in that old school book in the attic; it may be between the leaves of the family Bible; it may be in mother's scrap-book, yellow with age and hallowed by sacred memories; it may have been given you when you could scarcely read through the tears; it may be one of father's jovial jokes pasted on the side of his desk, or in that drawer long since unopened; it may be that clipping well worn from taking out of the pocket-book often to show a friend for a hearty laugh. Wholesome good cheer, humor, comfort, hope—those things that make dark days endurable and sunny days enduring. In this way I hope to get those priceless little gems which you have always looked for in your favorite periodical.

Heart throbs—yes, heart throbs of happiness, heart throbs of courage, heart throbs that make us feel better. **Those things that appeal to you must appeal to others**; that bit of verse—that note of inspiration laid aside—bring it forth and let us make a magazine that will speak the language of the heart as well as of the mind. I want you to send me these clippings to show me what kind of stories interest you, your mother, sisters, brothers, sons and daughters. I want to know just what kind of short, pithy articles you would select if you were sitting here with me at my editorial desk. You are constantly reading stories and anecdotes in the magazines, books, newspapers, or religious periodicals. Perhaps you have clipped them or pasted them in your scrap-book, or you may have remembered where you have seen such a story, and said to yourself, "Well, that's about as bright as it could be." That is the kind of a story I want.

The Greatest and Simplest Offer in the History of American Periodicals

I have placed on deposit with the First National Bank, of Boston, **TEN THOUSAND DOLLARS ($10,000)**. This money to be held in trust until the time specified below, when it will be divided among those who help me. To ten persons sending in the best ten clippings, I will give each one

A Pile of Silver Dollars as High as Each Successful Contestant

That is, if you secure one of the first ten awards, and measure six feet high, or four feet five, I will send by express as many silver dollars as will measure your exact height, one silver dollar placed flat upon the other. The others will be **10** awards of **$50** each for the next best stories; **20** awards of **$25** each for the next best stories; **100** awards of **$10** each for the next best stories; **200** awards of **$5** each for the next best stories; **500** awards of **$1** each for the next best stories.

840 AWARDS IN ALL

Remember you may clip the stories or verse out of an old newspaper or magazine, or an old book, or you may remember a story some one else has told you, or you have read in years past but cannot give the source. Write it out and send it in, but I would like to know where it was published and when, so as to give due credit, but this is not binding, if your memory fails you. They may be bright, cheerful, humorous, pathetic or biographical, or anecdotal—anything you would call a good story. Now don't delay, as this adv. only appears once. The only condition is to send 25 cent stamps for six months' subscription in advance with each clipping, and the story must not exceed 500 words. **These conditions are imperative and no deviation can be made.**

U. S. Senator Allison and Admiral Geo. Dewey will make the final awards on behalf of the Judges

These names are an absolute assurance of the sincere good faith and confidence which The National hopes to have from you.

In planning this contest, I am not only trying to find out what you think, but I want you to "Know Joe Chapple and His National Magazine." I want you to get acquainted with The National because there is nothing published like it. In the Washington Department, I take you with me to the National Capital, into the halls of Congress, in the committee rooms, up to the White House, in the Departments, and into the life of the great men and women you know publicly but not personally. It is my letter to your home folks. You can go with me over the length and breadth of our great land, feeling the National heart throb, seeing the every-day life of American men and women—the real romance of to-day in activities and achievements, for the railroad train is the home in which I spend part of my time seeing for you—and studying the great text book of life. As some one has said, "Joe Chapple's address is the United States of America."

Now I hope you understand how earnest and sincere I am in this purpose to have you "Know Joe Chapple and The National"—not that he is more than an ordinary, every-day mortal, but for the reason that he *is* one of you—and one who feels, thinks, acts and is devoted to the same purposes and ideals which you cherish.

WHEN THE AWARDS WILL BE MADE

Just the minute The National Magazine has 250,000 subscribers, I will send out by express Ten Thousand Silver Dollars to the successful contestants. We now print 203,000 copies, a gain of over 40,000 in last year's campaign. This will necessitate less than 50,000 new subscribers before the award is made. But, whether the extra subscriptions are received or not the $10,000 will surely be awarded before Sept. 1, 1905. All you have to do is to send the clipping with your 25 two-cent stamps, which is for a six months' subscription to The National Magazine. Address Dept. 21.

JOE CHAPPLE, THE NATIONAL MAGAZINE, BOSTON, MASS.

This is Your Page

¶ The American people can have anything they want.

¶ They have no excuse for kicking if they do not get it.

¶ It will not, however, come to them without effort. They must *express their will.*

¶ The will — that is, the wishes — of the community, is the sovereign ruling power that directs the policy of the Government and the practical working of our political institutions.

¶ It is "up to" the people to *say what they want* and to do so in the appointed way. This the only way to make sure of getting it. The trouble is that too many content themselves with the "initiative of indifference."

¶ The **Wishes of Our Readers,** taken as a whole, will afford the Editors of THE TECHNICAL WORLD their best possible guide.

¶ **Let us have these wishes expressed:**

What articles in this number pleased you most?
Answer ☞

1. _____
2. _____
3. _____
4. _____
5. _____

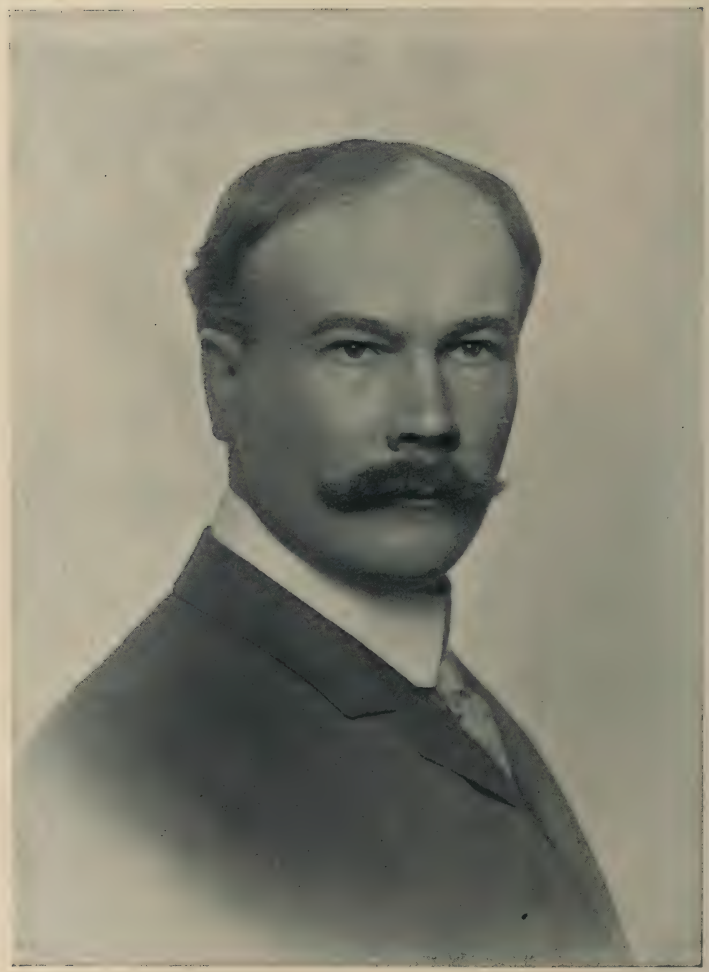
What subjects for future articles would appeal to you most strongly?
Answer ☞

1. _____
2. _____
3. _____
4. _____

Tear out this page and send it to The Technical World.

Name _____

Address _____



PAUL MORTON.
SECRETARY OF THE NAVY.

Born in Michigan, 1857, Since 1898, Second Vice-President, Atchison, Topeka & Santa Fé Railway Company.
Succeeded John D. Long of Massachusetts as Secretary of the Navy in the
Cabinet of President Roosevelt, 1904.

The
Technical World

Volume II JANUARY, 1905 No. 5

A Young Man's Chances in the New Navy

By Paul Morton
Secretary of the Navy

THERE has never been a time in the past history of the world when the comfort of naval service was so great as at the present, nor a time of peace when the emoluments of enlisted men in all ratings were so large; and there is no navy in the world in which the comfort and pay equal the conditions that exist in the Navy of the United States. It is also probably true that there has never in the past been a time, except during periods of actual war, when the opportunity for rapid promotion was so certain as it is now to come to bright, intelligent young men.

STERN VIEW OF U. S. BATTLESHIP *ALABAMA.*

The Sailor's Pay

Even in the lowest ratings, the pay of the Navy compares favorably with that of unskilled labor in shore life. Landsmen, on entering the naval service, receive an outfit of clothing worth $45, and go on the roll at a monthly pay of $16. They receive a ration calculated at a cash value of $.30 per day, in addition to their monthly pay—which, with the shelter and medical attendance afforded, makes a total fully equivalent to $30 per month, or $7.50 per week, shore wages; and this while being taught the rudiments of a calling. At the expiration of the period of training, which generally lasts about nine months to a year, landsmen are rated as ordinary seamen, with the pay of $19 per month.

Members of the engine-room force are enlisted as coal passers at $22 per month,

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BATTALION OF SEAMEN LANDING FROM U. S. BATTLESHIP *ILLINOIS*.

with a ration which makes their wage equivalent to at least $36 per month shore pay, or $9 per week. When qualified for firemen, second class, their pay is raised to $30 per month, which is equivalent, approximately, to $45 per month shore wages.

Chances of Promotion—Seaman Branch of the Service

Service in the Navy offers opportunity for advancement in two lines. The first is that of the Seaman branch, for which the original enlistment is made either as an "apprentice" or as a "landsman." The young man who enlists in the Navy as a landsman serves nine months to a year in training, at the expiration of which he is rated as an ordinary seaman. On the completion of about a year as "ordinary seaman," he will probably be qualified for the rating of "seaman," with pay of $24 per month, together with the additions previously referred to. At this point he may take his choice among several different divisions of the work of seaman, electing to perfect himself either in the duties of quartermaster (which relate to the handling of the ship while under way), in gunnery, or in the work of the boatswain (which relates to keeping the ship clean and in good condition, handling boats, anchor gear, etc.); or he may elect to qualify for the master-at-arms force, which is the police force of the ship. At the expiration of such a term of service as seaman as would ensure his proficiency to serve in a higher rating, he may be advanced, as vacancies occur, to be a petty officer, third class, with the pay of $30 per month. While still a seaman, he may receive an extra amount of pay of $5 per month for certain lines of service; and if he becomes an expert signal man, he will receive $1, $2, or $3 per

U. S. RECEIVING SHIP *VERMONT.*

MARINES AND SAILORS DRILLING ON AFTER-DECK OF THE *KENTUCKY*,
U. S. Training Ship *Hartford* in the Distance.

Athletics in the Navy.—Boxing.

month additional for this service, according to his expertness. The seaman, before the expiration of his first enlistment, may receive a permanent appointment as a petty officer, third class. If he re-enlists within four months, he will be given four months' pay of his last rating; and, on his second enlistment, receives an increase of $1.36 a month during the term of his second and each subsequent enlistment. At the expiration of his second enlistment, if his conduct has been uniformly good, he receives the good conduct badge, which entitles him to an increase of pay of $1.75 per month. If he so desires, upon his second enlistment, he may make application for a term of instruction in either the petty officers' school or the seaman gunner's school, where he will receive instruction which will qualify him for a further increase in rating. If he has been discharged as a petty officer, third class, he may, on re-enlistment, be rated as acting petty officer, second class; and on receiving an appointment as such, is paid at the rate of $35 per month, together with the various additional amounts to which he may be entitled. If he is rated as a gun pointer, he will receive, in addition to his regular pay, additional amounts ranging from $2 to $10 per month. This would work out for a gunner's mate, second class, upon receiving his permanent appointment at the expiration of the first year of his second enlistment, as follows: Regular pay, $35; ration, $9; if he is a heavy gun pointer, first class, $10; increase for re-enlistment, $1.36; total, $55.36, making, with the equivalent of quarters, medical attendance, etc., as good as $60 per month shore wages.

Writing Letters Home.
Scene on U. S. Cruiser *Cleveland*.

While not all enlisted men, of course, can qualify as heavy gun pointers, receiving the maximum amount above mentioned, there are equivalent schedules of extra pay in other lines of service, making the pay at this time equal to between $50 and $60 per month.

At the expiration of a year as petty officer, second class, the enlisted man is eligible for promotion to the rank of petty officer, first class, the pay of which rank is $40 per month, except in the case of turret captains, who receive $50. The year following, he may be promoted to be a chief petty officer with an acting appointment paying $50 to $70 per month according to rating. At the expiration of one year, he receives a permanent appointment with pay at $70 per month.

Artificer Branch of the Service

For the young man who has a mechanical turn of mind, and who chooses the Artificer branch of the Navy, there is equivalent promotion, and increase of pay. Starting as coal passer at $22 per month, he may become fireman, second class, at $30; then fireman, first class, at $35 per month; or he may enlist as a shipwright at $25 per month, and secure a promotion to one of the artificer ratings, equivalent to the rank of petty officer, third class, at $30 per month.

The list of trades represented in the number of ratings as first-class petty officer to which a young man may be promoted from an enlisted man at a lower grade, includes boilermaker; machinist, first class; coppersmith; ship-fitter; electrician; blacksmith; plumber and fitter; sailmaker's mate; carpenter's mate; water-tender; and painter. From these ratings, it is possible to secure promotion to the rating of Chief Petty Officer, as a machinist, electrician, carpenter's mate, or chief water-tender, the latter being the leading rating in the fireroom of war vessels, as chief machinist is the leading rating of enlisted men in the

BIG GUNS AND MEN OF U. S. BATTLESHIP *KEARSARGE.*

THE PRIDE OF THE AMERICAN NAVY.—JACKIES AND MARINES.

HELPING THE COOK.—VIEW TAKEN ABOARD THE *Massachusetts*.

engine-room, the pay being $50 to $70 per month, with rations and additional amounts for re-enlistments, etc. The rating of chief machinist, for example, paying $70, besides rations equivalent to $9; quarters, etc., equivalent to $5; and $1.36 per month for additional enlistment, makes a total of pay equivalent to over $85 per month, or $21 and some cents per week, which is higher by several dollars per week than the average wages of skilled mechanics ashore.

Pension on Retirement

The above statement is a summary of what any young man who will apply himself to the duties of the Navy may hope to attain after ten years' service. If he does not go further, he has secured a respectable position for as long as he may care to retain it, and with the certainty that when he gives up a seafaring life, the training and discipline he has undergone will make him a sought-for employee in shore life. If he continues to serve in the Navy, there are numerous opportunities for shore service at navy yards and in the instruction of recruits at shore stations. At the expiration of ten years' service, the enlisted man is entitled to a pension if he is unable to serve further because of physical disabilities, and if he is recommended for such pension by a board of officers. After the expiration of twenty years' service, he is entitled, either to a pension, on leaving the service, of one-half the pay of his last rating, or, at his option, to a home for the rest of his life at the Naval Home in Philadelphia. On the completion of thirty years' service, he may be retired on three-quarters of the pay of his last rating.

Warrant Positions

For the young man of good habits and character who will give some thought to the theoretical side of his calling, and

HANDLING AMMUNITION ON THE *Kentucky*.

will apply himself in spare time to study which will fit him to pass a reasonable examination, it is by no means a difficult matter to secure a warrant position ranking next below that of the lowest grade of commissioned officer. The requirements are that the applicant shall be less than thirty or thirty-five years of age, the age-limit differing for the various branches; he must have had seven years' sea service, one year of which must have been as a chief or first-class petty officer. If he is able to pass an examination in the duties he will be required to perform, he is given an acting appointment as gunner, boatswain, carpenter, or machinist; and on completion of a year of satisfactory service, is given a permanent warrant. Beginning at $1,200 a year full sea pay, a warrant officer receives an increase of $100 yearly for each five years until his fourth five years, when he receives $1,600; and, after twenty years' service, receives $1,800. Warrant officers frequently have independent commands of small vessels, have important shore duties assigned them, and, in addition to their pay, receive a ration and commutation of quarters on shore.

YOUNG SEAMEN LEARNING TO GO ALOFT.

Commissions Obtainable

For the exceptional young man, there is an opportunity for securing a full commission in the Navy. Twelve boatswains, gunners, or warrant machinists may be given commissions as Ensigns in any one year. To become an Ensign, a warrant officer must be less than thirty-five years of age, must have been a warrant officer for six years, must be recommended by his commanding officer, and must pass a satisfactory examination. Nine warrant officers — seven from the seaman branch, and two warrant ma-

TYPICAL AMERICAN JACKIES AND THEIR MASCOT.

chinists — have fulfilled these conditions in 1904, and have been commissioned as Ensigns in the Navy.

It is quite possible in the usual course of promotion in the Navy, for a boy to enter the service at 17; become a chief petty officer at 26, and a warrant officer at 27; serve six years as a warrant officer; and secure a commission at 33 years of age, which would probably re-

SIGNALING BY WIG-WAG METHOD ON SHORE.

READING LETTERS FROM HOME.

tire him at 62—the retiring age for all ranks—as a Captain.

With the certainty of continued and well-paid employment with an increase of pay for successive periods of service, and with the possibility of attaining all but the highest grade of the naval service, it is a fact that the chances thrown open by a naval career are well worth the consideration of every young man whose inclination is toward a seafaring life, and who is willing to accept it in all its phases and to make the best use of it and its opportunities.

The Way to Peace

By INGLIS MORSE

HE who would sweetly rest from haunting strife
That drives calm solace from the weary mind,
Must learn to let kind thoughts pervade his life,
And so, through these, the peace of Heaven find.

Hewitt Mercury Vapor Converter and Allied Apparatus

By P. H. THOMAS

Chief Electrician, Cooper Hewitt Electric Company

IN the August, 1904, number of THE TECHNICAL WORLD (p. 666), the Hewitt Mercury Vapor Lamp was described at some length. It was then made clear that the invention of Mr. Peter Cooper Hewitt was rather the discovery of a new group of phenomena in electrical physics than the invention of a new lamp. This lamp is merely one of the results of the discovery of the new principle.* The Mercury Vapor Converter is another.

Principle of Negative Electrode Resistance

This new principle, which concerns the passage of electricity through a vacuum tube or bulb, may be briefly explained. For electric current to pass through a vacuum, two electrodes are required, one to lead it in, and the other to lead it out. These electrodes are merely electrical conductors exposed in the vacuum space. The electrode by which the current enters is called the *anode* or *positive;* and that by which it leaves, the *cathode* or *negative*. The positive and negative electrodes must evidently be connected, respectively, to the positive and negative supply lines. It is found by experiment, that, except under certain conditions, a very great resistance to the passage of current exists at the surface of the negative electrode of a vacuum tube: and that to operate all types of such apparatus (except under these particular conditions), this great resistance has to be continuously overcome by the application of a high electromotive force.

The necessary high electromotive force has usually been obtained from an induction coil. Little or no resistance to the passage of current is found at the anode, however. This surprising resistance to current flow which is found at the negative—called the "negative electrode resistance"—is so great under ordinary conditions that many thousand volts are required to overcome it. Strange to say, all that is necessary to practically eliminate this negative electrode resistance is to maintain the supply of current continuous after the current has once started. If the current is interrupted, *even for an instant,* or if it fall to a low value (say below one or two amperes), the negative electrode resistance will assert itself, and no current can flow.

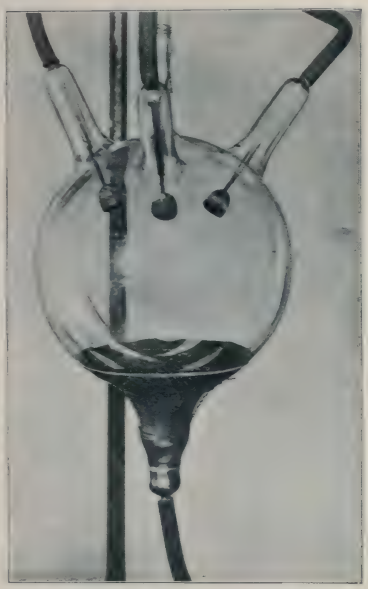


FIG. 1. THREE-PHASE MERCURY VAPOR CONVERTER AS ORIGINALLY EXHIBITED BY MR. HEWITT.

It will be noted that in all vacuum tubes the current must be started by high-potential or other means before the nega-

*NOTE.—It should be here stated that, unknown to Mr. Hewitt, Aarons of Germany had previously operated some small glass vacuum tubes, utilizing the same principle. The Aarons device, however, was not suitable for illumination, and was never further developed.

tive electrode resistance will disappear. In other words, whenever the initial negative electrode resistance is broken down, current will continue to flow, meeting only slight resistance until the current stops of itself, when the original initial negative electrode resistance will re-

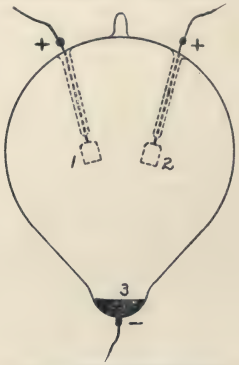


Fig. 2. Vapor Converter with Two Positive Electrodes.

establish itself. The reason that older types of vacuum apparatus do not act in the same manner as Mr. Hewitt's tube, is that the supply of current is intermittent in its nature, and that the negative electrode resistance is being continuously re-established by the interruption of the current. Further, it is found that a liquid negative, such as mercury, is the only one that will operate continuously without deterioration. The old types of apparatus practically all use solid negatives.

Mr. Hewitt discovered that current passing through a vacuum charged with mercury vapor causes this vapor to emit an intense light, with a comparatively small expenditure of energy. His discovery of how the negative electrode resistance can be eliminated, allowed him to make economical use of this very efficient and new method of producing light. Hence his mercury vapor lamp.

Applications

The great principle of the "negative electrode resistance" has thus been briefly explained. Various practical applications can be made of it, which may be summarized as follows:

1. Owing to the low *operating* "negative electrode resistance," a vacuum electric lamp can be economically used. (See description of Mercury Vapor Lamp in recent issue of The Technical World, above referred to.)

2. From the fact that an initial extra voltage is required to produce the state of low negative electrode resistance, a vapor converter can be constructed which will change alternating current into direct current.

3. Owing to this same property, the apparatus can be used as a circuit-breaker for alternating currents.

4. Owing to the combination of the two properties described above (1 and 2), the apparatus can be advantageously used as a discharge gap, sometimes called an *interrupter*, to replace the air spark gap commonly employed for wireless telegraphy and other purposes.

Direct from Alternating Current

To make clear the usefulness of the vapor converter, it will be necessary to state briefly the characteristics of alternating as distinguished from direct currents.

An electric circuit carries direct current when electricity passes in one direction continuously through the circuit. A circuit carries alternating current when at one moment electricity passes in one direction throughout the whole circuit, and at a later instant of time in the opposite direction throughout the whole circuit; and so on. Only direct current is suitable for charging storage batteries. Direct current is much more suitable than alternating for operating a great many classes of motors, such as elevator and hoisting motors, and, up to the present time, motors for street-car or railway work. It is found, however, that alternating current is very much more economical than direct current for transmitting and distributing electrical power. Consequently, since only direct current is suitable for many purposes, it will often be advantageous to be able to obtain direct current from alternating. This result can be accomplished, at the present time, by means of certain electrical apparatus called the "rotary converter," which is very similar to an electric generator or motor, but which is large and expensive, requires expert handling, and is not particularly efficient. It is the function of the vapor converter to provide a more satisfactory method of obtaining direct current when only an alternating-current service is available.

In the diagram *a*, Fig. 3, are shown the variations of ordinary alternating

current or alternating electromotive force. Consider that in this figure the distance of the curved line above or below the horizontal line indicates the strength of the current or voltage at any particular instant of time; and that, the further we go to the right on the horizontal line, the later the instant of time indicated. When the curve is above the horizontal line, the current in the circuit, or the electromotive force, is in one direction; and when the curve is below the horizontal line, it is in the other direction. It will be noticed that in changing from one direction to the other, the value of the current or voltage gradually decreases to zero, and then increases in the other direction up to a maximum, when it again decreases to zero, and returns to its original direction; and so on.

Let us now consider the Hewitt apparatus. This may be briefly described as a large glass bulb or globe, with a small puddle of mercury at the bottom constituting the negative electrode, and, supported from the top part of the bulb, two or more electrodes of iron or other material. These electrodes are of various shapes, and usually not over one or two inches in size. Platinum lead wires run from all the electrodes to the outside line wires, through the glass, which makes a perfectly air-tight joint with this metal. The bulb is exhausted as perfectly as possible of all gases except mercury vapor. A converter of this type is shown in Fig. 1. In some cases it is desirable to make the electrodes all of mercury. Such a converter, with four positives and a negative, is shown in Fig. 8.

On account of the nature of the negative electrode resistance, if we connect a Hewitt mercury vapor apparatus across suitable direct-current mains, and start it by breaking down the negative electrode resistance, current will flow steadily until it is stopped by means external to the apparatus, this being the proper operation of the apparatus on direct current for giving light.

Suppose, however, we suddenly change the direct current to alternating current. At the instant of change, nothing new occurs. There is no difference in the operation of the apparatus, since we shall assume there is at the instant no change in the current. Then, referring to Fig. 3, at point *A*, where we shall assume the alternating current begins, it will be observed that the value of current begins to decrease, until finally a zero point is reached at *B*. At this time, of course, current ceases to flow. Meanwhile the alternating electromotive force or voltage is reversed, and begins to increase in strength. This reversal of direction makes the other electrode of the apparatus the negative; and, if we provide no means of overcoming its initial negative electrode resistance, no current can flow. The same condition will exist also when the alternating force has again become zero, and flows in its original direction, as indicated at the point *C* (Fig. 3). If the electrode resistance were broken down again at this point *C*, of course, the lamp would start again,

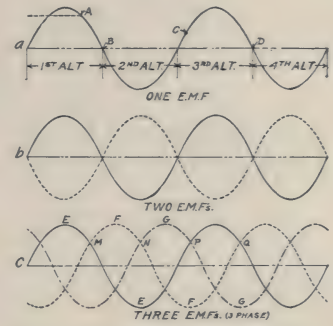


Fig. 3. Curves Representing Single-Phase and Polyphase Electromotive Forces.

and would run until the current again became zero at the point *D*. It is thus evident that this apparatus cannot run continuously of itself on alternating current.

Suppose, however, instead of the ordinary lamp, which has but two electrodes, we use an apparatus like that shown in Fig. 2, which has two electrodes at one end, and one at the other. Suppose we pass direct current between electrodes 1 and 3 in such a direction that 3 is the negative or cathode. Then, as in the mercury vapor lamp, current will continue to flow between these electrodes; and the negative electrode resistance of electrode 3 will be practically

eliminated by this current. Suppose, now, we apply, in addition to this direct current, the alternating electromotive force of Fig. 3 between electrodes 2 and 3. When the alternating electromotive force is at the point *A*, current will flow from 2 to 3, since 3, being the negative for the alternating current as well as for

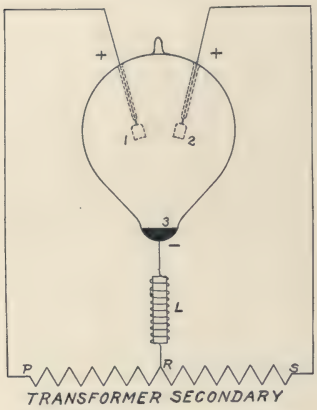


Fig. 4. Converter for Single-Phase Alternating Current.

the direct, has no negative electrode resistance, on account of direct current which flows to it from electrode 1. As the alternating electromotive force changes to the opposite direction, it attempts to flow from 3 to 2; but, since in this case electrode 2 is its negative, and since its initial electrode resistance is not broken down, the reverse alternation of the alternating current cannot start. When the alternating electromotive force returns to its first direction again, however, 3 is its negative, and current will flow as before.

Thus only those alternations of the supply which have the direction from 2 to 3 can pass, and we have succeeded in getting one kind of direct current from an alternating source. The intermittent character of this current is shown at *a* in Fig. 5. This is perhaps the simplest form of converter. The direct current, however, though all in the same direction, is intermittent, and not well adapted for some kinds of work.

Take another case. Suppose we have a second alternating current exactly opposite to the first, and suppose we have a fourth terminal in Fig. 2 similar to Fig. 1, and that the new alternating current is sent from the new electrode to 3. The relation of the two alternating electromotive forces is shown in Fig. 3. It is evident that the second alternating current, like the first, will pass only those alternations which are in the right direction, and that the others will be suppressed. But the former come just at the times when the first alternating current is not acting, so that the gaps of direct current left by the first are filled in by the second, and the current flowing in the negative is much more nearly steady than in the first case. This current is shown at *b* in Fig. 5.

Should the direct current from 1 to 3 be suddenly stopped, alternating current would continue to flow from 2 or from the extra electrode, whichever happened to be then operating, until the first zero point was reached, when, since both alternating electromotive forces are zero at the same time, all current would cease and the apparatus refuse to operate.

Now, suppose that the vapor apparatus shown in Fig. 1 be operated without direct current, and suppose that three different alternating currents be applied, each one between the negative and one of the three positive electrodes. These alternating electromotive forces are to be considered as three-phase electromotive forces—that is, each one lags 1-3 of a complete double alternation behind the one before it, as shown in *c* (Fig. 3). Suppose the electromotive force *E* in this figure to be passing a current from its proper positive electrode to the negative in the three-phase converter, shown in Fig. 1. As this electromotive force becomes less and less until the point *M* is reached, the current through the converter would become less; but at this point the electromotive force *F* is seen to have risen to the same value in the same direction to which the electromotive force E has fallen; and thus, evidently, the electromotive force *F*, becoming greater than *E*, takes the current from *E*, and causes the current to increase in value again, following the curve *F* of the figure until the point *N* is reached, where

the electromotive force G in turn takes the current away from F, and carries it to the point P, at which the electromotive force E, having gone through a complete half-cycle, is ready again to take up the current from G and carry it to the point Q; and so on indefinitely. With this type of circuit there is evidently no time at which the current through the negative electrode becomes zero; and, consequently, the converter continues to operate indefinitely without the necessity of supplying direct current.

Such three-phase electromotive forces as are here described can be obtained from any three-phase circuit in which the neutral point is available. This is the type of converter first shown by Mr. Hewitt. It will readily be seen that in this case the direct current in the negative electrode—which is the current that is available for useful work—has a much steadier value than would be obtained by the apparatus of Fig. 2. Similarly, with an apparatus having still another positive electrode and four alternating-current electromotive forces, we should again have a converter in which the electromotive forces so overlapped as to require no direct current for bridging the zero points of the current. Such alternating electromotive forces can be obtained from any two-phase or ¼-phase circuit where the neutral point is available. In this apparatus the current in the negative is still more nearly steady than in the case of the three-phase converter.

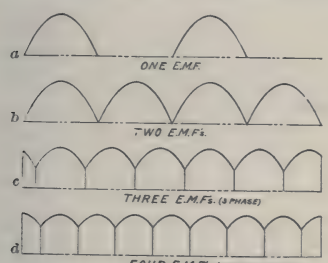


FIG. 5. PULSATIONS OF DIRECT CURRENT FROM VARIOUS TYPES OF ALTERNATING-CURRENT SUPPLY CIRCUITS.

The currents from the different types of alternating-current circuit are compared as to steadiness in Fig. 5. In this figure it is assumed that there is no choke coil to smooth out the variations of the current; whenever such choke coils are used, the current is materially steadied.

On many alternating-current circuits, however, only one voltage is available, and there is no direct current for bridging the zero points as was found necessary in Fig. 2. For these cases, it is very desirable to have some means of operating a vapor converter. This can be accomplished by the apparatus shown in Fig. 4, which is the same as that of Fig. 2, except for the connection to the supply circuit, and except for the choke coil placed in lead from the negative electrode.

Referring to the figure, suppose that the voltage between the electrode P and the middle point R of the supply transformer be supplying current through electrode 1; this current is delayed behind the electromotive force, since it has to flow through the choke coil. This means that when the electromotive force from 1 has dropped to zero, the current has not yet reached zero, since it lags behind. The converter does not go out at this instant. It would, however, go out a little later, when the current finally did reach the zero point; but the electromotive force between the terminals S and R, which is exactly opposite to that between P and R, is trying to force current from electrode 3 to electrode 1, and, on account of the lag of the current from 1, it will pick up this current before it becomes zero, and maintain it through the rest of the alternation, until this electromotive force in turn approaches zero. Again, since the current is lagging behind, the electromotive force between P and R will pick it up from R and S before it actually becomes zero, preventing the converter from stopping; and so on. The simple introduction of the choke coil enables the apparatus of Fig. 2, when supplied by the proper electromotive force from a single-phase circuit, to operate indefinitely without the use of auxiliary direct current. This is one of the most important applications of the converter. On account of the choking power of the coil, this arrangement gives quite a steady current; but, as in most of the cases above, it requires the neutral point of the alternating-current supply.

The vapor converter itself has a number of interesting characteristics. Its vacuum is similar to that of the mercury vapor lamp; on the other hand, since it is not intended to give light, its length is as short as possible; this means that the voltage across the converter, which represents its total resistance, is reduced to 10 or 15 volts. As in the mercury vapor lamp, this voltage is practically constant, regardless of current, except for small current. On the other hand, since with large currents in the container there is a considerable loss of energy, there is developed within the enclosing chamber a considerable amount of heat, which must be dissipated. It is therefore necessary to make the container itself of consider-

Fig. 6. Mercury Vapor Circuit-Breaker.
a — Circuit Closed.
b — Circuit Open.

able size to get cooling surface; the mercury of the negative electrode is evaporated during the operation, and condenses on the surface, flowing back again to the electrode.

It is necessary to provide some means for the starting of the converter. This is accomplished in a number of ways, involving the same principles as the starting of the mercury vapor lamp. The converter can also be arranged to be started automatically.

These converters will be especially useful for charging storage batteries from alternating-current supply circuits; for running small direct-current motors; and, when built in larger sizes, for operating railway motors from alternating-current circuits.

As a Circuit-Breaker

The third application of the Hewitt mercury vapor apparatus is its use as a Circuit-Breaker for alternating currents.

It is of course necessary, in all electric plants, to have means for connecting and disconnecting motors, lights, circuits, etc., as may be required; and it is usually very desirable that means should be provided for automatically stopping the flow of current in any circuit when any accident occurs to the apparatus on this circuit. These functions are performed by many different types of switches and circuit-breakers, which, on large high-tension plants, are very cumbersome and expensive, especially when automatic. In many plants, the size of the switching apparatus is so excessive that it is impossible to place the switches and circuit-breakers for operating the plant within view of the operator, who must rely on indicating devices to determine the condition of his circuits. On the principle of the mercury vapor apparatus, it is possible to construct a circuit-breaker which will accomplish this same work with a very much less cumbersome and bulky apparatus.

To understand how the principle of the negative electrode resistance may be applied to this apparatus, we may consider the circuit-breaker in *a*, Fig. 6. Suppose that the current, in flowing from the generator to the circuit, passes through the vapor apparatus, going in by one lead, passing through the mercury from one cup to the other, and passing out on the other lead. We have thus an ordinary metallic circuit through the apparatus; and, as long as the circuit-breaker remains in this position, current continues to pass as though it were not a vacuum apparatus.

Next, suppose it is desired to stop the flow of current; the circuit-breaker is then tipped into the position shown in *b*, Fig. 6, in which the mercury separates

between the two cups. At the moment of separation, the current, which has been flowing through the mercury from cup to cup, is obliged to pass through a portion of the vapor, making the mercury in one cup the negative electrode, and that in the other the positive, it being merely accidental which way the alternating current may happen to be flowing at the instant of the separation of the mercury. As was explained in the description of the mercury vapor lamp, when a separation is made between the negative and the positive electrodes which have been in contact and are carrying a current, the negative electrode resistance does not form, and the current passes freely through the vapor. The current breaker is thus for the moment operated as a mercury vapor lamp, and will continue thus to operate until the current becomes zero. Since we are dealing with an alternating current, the current will become zero at the end of the first alternation; and when, in its natural course, the voltage rises in the opposite direction, the negative electrode resistance has become re-established, and current cannot flow. As a result, alternating current has been interrupted. As long as the circuit-breaker remains in the position of *b*, Fig. 6, no current will flow. However, if it be desired to start the flow of current again, it is necessary merely to tilt back the circuit-breaker into the first position, when, since mercury now joins the two cups, current will flow unimpeded as at first.

The mercury vapor device has other advantages over the present types of circuit-breakers, for all contacts are made by mercury which, being in a vacuum, cannot become corroded; consequently there are no bad contacts, and no solid switch-tips to become burred or burned. The whole apparatus is so small as to be readily operated automatically.

In the mercury vapor circuit-breaker, some interesting problems in construction arise. For example: It is difficult to get the current, when of considerable volume, from the external circuit, through the glass sealing chamber, to the mercury within, the difficulty being the tendency of the current to heat the leading-in wire, causing it to expand and crack the glass. It is possible, however, without serious mechanical complications, to introduce a very large current into the vacuum without causing any leaking seals.

FIG. 7. MERCURY VAPOR DISCHARGE GAP FOR HEAVY CURRENT.

As a Discharge Gap

The fourth application of the mercury vapor apparatus, which has been frequently described in the technical press, is the Discharge Gap, sometimes called the *interrupter*. The function of the discharge gap is easily explained. For the production of X-rays, the sending of wireless telegraph messages, and many other purposes, it is necessary to have extremely sudden discharges of high-potential electricity. These are always obtained by introducing into the circuit from which the discharge is to be obtained, an air-gap or its equivalent, and by raising the voltage until this air-gap is unable to resist the strain, and breaks down. At this instant, there is a very sudden rush through the circuit of the electricity which has been previously accumulated on both sides of the air-gap; and this sudden discharge serves to send the wireless message, or excite the X-ray tube. But a disadvantage to be found with air-gaps is, that, even after they break down, they introduce a considerable resistance into the circuit, which prevents this discharge from being perfectly free as is most desirable. A further disadvantage to be met with in the air-gap is that an undesirably long time is required for it, when once it has been heated by the discharge, to cool sufficiently to be able to operate properly a second time. In addition, whenever these gaps are used for large quantities of energy, or continuously, the metal electrodes become scarred and burnt, and require constant replacing.

Fig. 8. Converter with Four Mercury Positive Electrodes.

The mercury vapor apparatus shown in Fig. 7 may serve the same purpose as the air-gap, for, if we apply a comparatively low voltage between the two electrodes, no current will flow, because of negative electrode resistance, unless we raise the voltage sufficiently to overcome this resistance. Then the discharge of electricity will be practically free, since, when once broken down, the negative electrode resistance is substantially eliminated. Thus, by the use of the mercury vapor apparatus, the resistance to the discharge, introduced by an air gap, is eliminated.

Furthermore, it is found by trial, that, even with a series of the most rapid discharges, the negative electrode resistance can always be re-established between them, which is by no means true of the air-gap. And again, evidently, the burning and burring of the electrodes of the air-gap are eliminated, as the mercury cannot corrode in a vacuum.

The action of the mercury vapor discharge gap has been carefully studied by the rotating mirror method, and has been found to be free in a remarkable degree from the weaknesses of the air-spark gap. Fig. 7 shows a discharge gap used by Mr. Hewitt in his laboratory on some of his high-tension work. These bulbs are about five inches in diameter.

In addition to the applications so far described, there are others of less immediate importance, which space will not permit to be described here. It must be remembered that the discovery of the great principle of the negative electrode resistance is quite recent, and that it is a radically new phenomenon, and consequently capable of producing most unusual results.

PARADE OF 4,000 SEAMEN AND STOKERS AT PORTSMOUTH.

Training of the British Tar

Foundation of Britannia's Maritime Supremacy—The Drilling of Seamen, Upon Whose Efficiency Chiefly Depends the Strength of the Empire's First Line of Defense

By WALDON FAWCETT

GREAT BRITAIN, eager to maintain the prestige accruing from her position as the leading naval nation of the globe, is spending annually an immense sum of money in training young men for service in her Navy. Whether the system employed is calculated to give to the naval sailors of the United Kingdom as perfect an intellectual and physical equipment for their sea duties as is afforded by the methods of some other nations—notably the United States, is a question open to argument, and is to-day a topic of animated discussion in international naval circles. But whatever be its merits or demerits, the British system of training bluejackets is interesting and instructive. Particularly may observation in this field be profitable to Americans, for, aside from the ties which bind the two nations, there is the fact that a considerable portion of the foreign seamen under the

SEAMEN AT SINGLE-STICK EXERCISE.

THE HOPE OF THE BRITISH NAVY.

Young seamen at physical drill, Portsmouth Dockyard.—The ships here shown are a small portion of the Fleet Reserve.

Stars and Stripes received their preliminary training as British tars.

The First Line of Defense

For a proper appreciation of the importance that attaches to the training of the British bluejacket, it is necessary to bear in mind that for Great Britain—with her world-wide possessions, and almost absolutely upon the Navy for its food supply. The densely populated islands never have in reserve more than six weeks' food supply; and thus, after all, it is primarily as a safeguard against famine that John Bull maintains at enormous expense a fleet of about half a thousand warships, manned by more than 110,000 officers and men, and involving an annual expense of fully $115,000,000 for maintenance and for the new construction necessary to preserve preëminence in naval equipment.

BRITISH RECEIVING SHIPS, WITH RECRUITS.

The vessel moored in the foreground is the old line-of-battle ship *Marlborough*.—Her amidships and forward decks are housed over for permanent shelter.

dependent, as she is, upon foreign commerce—the Royal Navy constitutes a "first line of defense." For this maritime nation, the sea is not merely a water highway from one country to another, but is in addition a dominion to be policed, patrolled, and guarded. The integrity of Britannia's widely scattered colonial empire, the security of the commerce which is the backbone of her prosperity, and, finally, the safety of the three exposed islands comprising the United Kingdom, all depend upon the mastery of the sea.

The matter is brought home to every British citizen, moreover, by the fact that the country depends, in the last resort,

Notwithstanding the immense force of enlisted men necessary to keep in commission a fleet of this size, there has never been a lack of seafaring men to meet the requirements of the Navy. Perhaps this is due in part to the fact that the emoluments, while not comparable with those of the American Navy, are nevertheless quite liberal in comparison with the general British wage scale. The young man entering the British Navy has almost as much chance of promotion as the lad in the American service.

TARGET PRACTICE.
Scene on Board H. M. S. *Talbot.*—A 12-Pounder in Action.

Trained from Boyhood

Beginning his naval career on board one of the training ships stationed at Portsmouth, Portland, Devonport, Falmouth, or Queensferry, the young Britisher qualifies as a "first-class boy;" and is subsequently drafted, after a six weeks' cruise on a training brig and a six months' course on a depot ship, to a coveted place on a sea-going training ship. Here begins his real career in the Navy. If he progresses advantageously, the young man goes in succession through the different grades of "ordinary seaman," "trained seaman," and "leading seaman." Hard work will win promotion to the rank of "petty officer, second class." The rank of "petty officer, first class" is the next step in his advance; and after that, the young man, if he has the requisite energy, ambition, and ability, will successively occupy the positions of "warrant officer," "chief boatswain," and "chief gunner."

The British naval policy requires that new recruits shall enter the service earlier in life than is obligatory in the United States Navy. No boy, no matter how promising physically or intellectually, is received into the British

Instruction in Use of Lead and Compass.

Rifle Drill on Shipboard.

TARS OF H. M. S. *POWERFUL* AT PHYSICAL DRILL.

Navy after he has passed his sixteenth year; and each lad binds himself to continue in the service for twelve years—a much longer term of enlistment than prevails in the American service. The juvenile British tar, as has been explained, is likewise more poorly paid than his American cousin. Indeed, his wages for a considerable time after he goes aboard the old wooden man-of-war which serves as a training ship, amount to only a few cents per day, in addition, of course, to board and clothing.

In the British Navy, and particularly on the naval training ships, no end of attention is devoted to making the lads physically fit. Boxing and other athletics are encouraged in every possible manner. In the British, as in the American Navy, the theory obtains that the training of the old-time sailor is the best in the world for giving to his twentieth-century successor a quickness and accuracy of hand and eye, and steadiness of nerve and foot. Accordingly, the young men on the ships flying the Union Jack are taught all manner of work with rope and canvas; learn to make sail and to

STRETCHER DRILL.

take hand-lead and deep-sea soundings; master the knack of steering into and before the wind; accustom themselves to manning, lowering, and pulling boats; and, in short, acquire the all-round knowledge that constituted the stock-in-trade of the all-round seaman on the fighting craft of the old days.

When a young man in the British Navy has advanced to the rank of "first-class boy," he receives twenty cents per day in addition to board, lodging, clothing, and medical attendance. The amount seems small in comparison with the sum paid for corresponding service in the American Navy; but nevertheless a young Englishman who is apt and alert can work his way up to a very profitable position in the service of his country, such, for instance, as the post of chief gunnery instructor on a battleship, where the pay is nearly $70 per month—the equivalent of $70 net profit, since the seaman has no expenses save those for amusements. Marriage for the men who are working their way up in the British Navy, is not discouraged to the extent that it is in the American military and naval service. There are few petty officers, even of the second class, who have not wives at the home station; while not a few helpmates follow their husbands to a colonial or foreign station, and set up a sailors' lodging house or some other business enterprise.

British officers are wont to claim that seamen who have passed through the regulation course of training in His Majesty's Navy are the superiors of any other men of their class in actual seamanship; but this is by no means conceded by other nationalities, particularly the Americans. It must be admitted, however, that the British tars take more kindly than do the Yankees to the dirty, unpleasant, and exhausting work of feeding fuel to the furnaces in the hold of a naval vessel, and of coaling warships. To be sure, they do not do this kind of work with as good grace as the Germans and Scandinavians; but withal they will carry the work through with only a moderate amount of grumbling—a tribute, perhaps, to the stricter discipline prevailing in the British Navy.

MEN OF THE ROYAL NAVAL DEPOT SHIPS AT PORTSMOUTH.

Five Thousand Men in Line.—A typical scene in the event of a sudden crisis, such as the recent tension with Russia over the North Sea incident, showing England's naval preparedness.

One feature in which the British methods of naval training are conspicuously deficient in comparison with the American, is found in the instruction in gunnery. As is well known, this is made a specialty in the Navy of the United States. On the other hand, some of the British ships yet carry the old 10-inch muzzle-loading guns; and on all the

CLASS OF TORPEDO AND SUBMARINE MINE MEN, WITH ELECTRICAL EQUIPMENT.
Part of crew of H. M. S. *Vernon*.

GUN DRILL ON BRITISH BATTLESHIP *ANDROMEDA*.
A 6-inch gun in action.—Wounded gunner being removed to ship's hospital on stretcher.

British training ships the boys are taught how to handle such muzzle-loaders—an accomplishment that would be of very little use were they engaged in a battle in which their opponents were equipped as are all modern war vessels, with breech-loading, quick-firing ordnance. Moreover, the expenditures authorized by the British Government for powder and ammunition for target practice, are by no means on the same scale as those in the case of the American Navy; and the result of this economy is seen in the comparatively poor scores made by British naval gunners when their marksmanship is subjected to tests.

BOAT CREW AT DRILL.

The Stimulus of Association

If there be aught in association, the young tars of the British Navy should derive some benefit from the influence exerted by mementoes of Nelson, Drake, and other famous sea warriors, for some of the ships of these heroes of bygone days are still in use as training vessels. The *St. Vincent,* which serves as a training ship at Portsmouth, was built in 1815; and the *Dædalus,* one of the Naval Reserve drill ships, first went into commission in 1828. Other old training ships include the *Black Prince,* built in 1861; *Boscawen,* 1841; *Britannia,* 1860; *Cambridge,* 1858; *Lion,* 1847; and *President,* 1830. Moreover, there is still in commission as the flagship at Portsmouth harbor, the *Victory,* which was Nelson's flagship in the famous battle of Trafalgar —a vessel built in 1765.

The Naval Reserve

In the United States the Naval Reserve might almost be said to be yet in its infancy; but in Great Britain the corresponding organization constitutes one of the greatest sources of strength of the Navy. Many boys enter the Naval Reserve young enough to be fascinated by their taste of the life, and enlist in the Navy—or at least in the Marines, if they are too old to gain admittance to the naval service. The greatest usefulness of the Naval Reserve, however, is as an auxiliary to the regular naval force. In the strongholds of the merchant marine, such as the ports of Bristol, Swansea, Liverpool, Hull, and Glasgow; and in many of England's colonial possessions, such as Newfoundland, there are hundreds of men who are, from long experience, first-class sailors, and who need only instruction in gunnery to transform them into first-class man-o'-war's men. This training and drill they receive during the annual practice cruises of the various detachments of the Naval Reserve on board British men-of-war.

The Auxiliary Fleet

Indirectly at the disposal of the British

Navy, is another training domain for British tars which would yield valuable material should war necessitate volunteer additions to the regular personnel of the Navy. Reference is made to what amounts to a supplementary fleet of school ships—namely, the large liners of the mercantile marine. Although engaged in regular passenger and freight-carrying traffic, many of these ocean "greyhounds" have been built in accordance with plans approved by the British naval officials; are regularly subsidized by the Government; and, in the event of war, could instantly be pressed into service as auxiliaries, instead of it being necessary to make hasty purchases of vessels for an auxiliary navy, as was the case in the United States at the time of the Spanish-American War.

The facilities afforded by this auxiliary fleet in reserve, enable the British naval authorities to pursue the manifestly advantageous policy of never losing sight of a really promising candidate for the Navy. If, as frequently happens, the ranks of the Royal Navy are so well filled that no new recruits can be taken, or if some minor disqualification prevents the acceptance of an otherwise satisfactory applicant, the officials endeavor to find places for the young men thus turned aside, on the great liners of the auxiliary mercantile fleet. In order that the Navy may have the full benefit of this supplementary training service, the Government encourages its naval officers to retire early, or to take long leaves of absence from the regular service, in order to accept positions as first and second officers on the largest

LIGHT GUN DRILL.

steamers of the merchant marine. Thus the apprentices who, failing to get into the regular Navy, find berths on the large merchant vessels, are usually under the instruction and direction of competent naval officers. Indeed, many a powerful mail-carrying steamer sailing from British ports is so well officered and manned, that, in the event of a sudden declaration of war, she could be transferred to the government service without the necessity of making a single change in the personnel.

Last Days of Naples

The Black Record of Vesuvius—Ominous Possibilities Suggested by the Present Eruption of the Historic Volcano

By JOHN ELFRETH WATKINS

NAPLES, the most densely populated of the world's great cities; that quondam resort of the wealthiest nobles of ancient Rome; that "City of the Siren," within whose four square miles huddles together a population greater than that of Boston, has shuddered again, for the seething hell pent up beneath her has again burst the Vesuvian gate.

Will some Bulwer Lytton of the near future have a chance to put to paper a "Last Days of Neapolis?" This question seismologists are asking with greater anxiety than they have betrayed for a generation past. For it is a well-accepted theory now that Vesuvius is but the vent of a vast fiery chasm undermining the Italian metropolis, whose thin crust of earthy foundation may any time give way, precipitating more than half a million souls into the roaring furnace below.

Immunity Due to Patron Saint

The center of the sea front of Naples is but nine miles due west of the eruptive cone. Its postern gate is scarce further down the lava slope than the ruins of Pompeii; but although the ashes of the great volcano have frequently darkened the city and thrown the Neapolitans into terror, and hot lava has flowed almost to its very gates, never has a soul within its walls suffered from the Vesuvian wrath. For five scores of times since Pompeii was destroyed in the first century of the Christian era, has the great black background of Naples belched forth. Ask the orthodox Neapolitan the wherefore of his immunity, and he will attribute it to the protection of the city's patron, San Januarius.

In ancient times some pagan divinity may have closed its gates against the black lava flows squirming snake-like down the mountain; for Naples is centuries older than the days of Glaucus and the blind Nydia. The original city, founded by a Greek colony, was named Parthenope in honor of one of the sirens.

BAY OF NAPLES.

TOURISTS ON BRINK OF CRATER OF VESUVIUS.

ROYAL OBSERVATORY NEAR CRATER OF MOUNT VESUVIUS.
This post, though frequently threatened with destruction, has never been deserted since its erection over thirty years ago.

This was augmented by a second colony of the ancient Hellenes, who added the new city. In the fourth century before Christ, it fell into the hands of the Romans, who gave the combined settlement the name Neapolis, or "new town." On its neighboring hill, Posellopo, Virgil composed his *Georgics*. Within the city proper, Nero made his first appearance on the stage.

The Vesuvian volcanic region, like that of Aetna, is partly land and partly sea, including all the Bay of Naples—sometimes called "The Crater"—lying at the very foot of Vesuvius, with a circuit of fifty-two miles, and having the metropolis at the extreme northern corner.

Birds in the Cannon's Mouth

The whole base of the mountain is skirted by a series of villages, where abide 100,000 souls—birds nesting in the cannon's mouth. Between these settlements, and even above—within the jaws of the fiery demon—the tourist sees scattered huts, tent-shaped, of straw interwoven. After the great eruption of September, many of the villagers deserted their homes and camped in the open, further below. Time and again have the lands of their ancestors been engulfed by the seething lava, yet has this daring humanity persisted in returning to the danger zone. And why? Simply because each renewed eruption adds fertility to the soil, resulting from decomposition of the volcanic products.

A road twenty miles long, commencing at Naples, extends southeastwardly along the shore of the bay, and then, winding inland, completely encircles the mountain. This is dotted with villages, all within hearing of the volcanic rumblings and bellowings.

Four miles down the bay road from Naples lies Portici, its 12,000 population dwelling peacefully upon lava thrown down to the sea by the eruption of 1631. On this black bed stands the Royal Palace, built by Charles III., in 1738. Resina, one mile further on, is the favorite suburban seat of wealthy Neapolitans. Its 14,000 residents dwell partly upon the ruins of Herculaneum. Resina is the town from which the ascent of Vesuvius is made, and is the chief abode of the Vesuvian guides.

FUNICULAR RAILWAY UP CONE OF MOUNT VESUVIUS. Damaged by Eruption of September, 1904.

Rebuilt Sixteen Times

Sixteen times has the burning mountain overwhelmed Torre del Greco, two and a-half miles further on; yet within four and a-half miles from its destroyer, the seventeenth town flourishes with 25,000 population. There is a saying among the Neapolitans, "Naples commits sins and Torre pays for them." Torre del Greco is the center of the Mediterranean coral fishery, and is surrounded by rich vineyards as well as fruit orchards. From its grapes some of the choicest wines of Italy are made, notably the *Lachrymæ Christi.*

Five miles further along is Torre del Annunziata, a large fishing town of 16,000 people. Turning a mile inland here, the traveler views the ruins of Pompeii.

Previous to the year 63 A. D., Vesuvius was not recognized by the Greeks and Romans as an active volcano. At that time the summit was a large crater, for centuries regarded as totally extinct. The first warning of renewed eruption within historic times was the earthquake of 63. Moderate earthquakes followed at intervals until the disturbance culminated in the great catastrophe of 79, destroying not only Pompeii and Herculaneum, but Stabiæ, Retina, and Oplontum.

Of the succession of ancient eruptions which followed that depicted by Bulwer Lytton, the most severe fell in 203, 472, 512, and 993. The first recorded discharge of lava since the last days of Pompeii occurred in 1036, or thirty years before the Normans conquered England.

Eighteen Thousand Killed

The first great modern eruption was that of 1631, eleven years after the Pilgrim Fathers landed on Plymouth Rock. For a long time before this outburst, the peaceful crater had become so overgrown with vegetation that it offered a jungle for wild boars, while cattle grazed on the slopes a little below. But a sudden tidal wave of lava, utterly unexpected, engulfed 18,000 people, many of the coast towns being wholly and the remainder partially wiped out. Another outburst, in 1676, was remarkable for having thrown a perpendicular stream of lava high in the air.

From scattering eruptions in ancient, mediæval, and early modern times, the outbursts had increased to nine in the seventeenth century. The eighteenth was to increase this to 26.

Terror in Naples

In 1707 the volcano sent forth a cloud of ashes so dense that at midday in the streets of Naples the blackness of the darkest night reigned supreme. The shrieks of terror-stricken women pierced

NATIVE HUTS NEAR POMPEII, IN SHADOW OF MOUNT VESUVIUS.

the air, and the churches were crowded by the populace. The relics of San Januarius—his skull among them—were carried in procession through the streets. Thirty years later, a stream of lava one mile wide and containing 300,000,000 cubic feet burst from the mountain side. The next notable eruption was that of 1760, when new cones formed at the side. Seven years later the King of Naples hastily retreated into the capital from the palace at Portici, threatened by a fresh outburst, and found the Neapolitans again in confusion. A frenzied mob set fire to the Cardinal Archbishop's gate because that functionary refused to bring out the relics of the patron saint. Finally, forcing him to produce the skull, they carried it in a procession alleged to have immediately quieted the demon of the mountain. Twenty-two years later, while our patriot fathers were in the midst of their struggle for freedom, a column of liquid fire burst from the crater, and rose to three times the height of the mountain. This was followed by a black cloud emitting flashes of lightning and advancing toward Naples, where the theaters were immediately closed and the sacred relics again paraded. An eruption lasting a year and a-half commenced in 1793. Lava was emitted for fifteen hours, and the sea boiled 100 yards from the coast.

Gaining in Frequency

That the Vesuvian eruptions are gaining in frequency is attested by the record of the nineteenth century. The first of note occurred in 1822, when the top of the great cone fell in and a lava stream a mile in width poured out. Altogether 800 feet of the cone was blown away, leaving a hole 938 feet deep in the crater. Twelve years later a river of lava nine miles long wiped out a town of 500 houses. One stream threatened Pompeii with another interment. Lava flowed almost to the gates of Naples in 1855, and caused a deplorable loss of property to the cultivated region above. Twelve years later a new cone was raised to a height greater than that attained by any in historic times.

Great Outburst in 1872

Blocks of stone forty-five feet in circumference were hurled down the mountain by the spectacular outburst of 1872. Two lava floods rushed down the valley on two sides, ashes were shot thousands of feet in the air, and the sea rose for miles. More than 20,000,000 cubic feet of lava was ejected in a single day. A cloud of smoke enveloped parties of tourists escorted by guides. They were caught under a hail of burning projectiles and close to a lava torrent. An unknown number, including eight medical students, were buried beneath this seething stream.

Since 1879 Vesuvius has been variously active, there being two eruptions of note in 1900; two others in 1903. But

RUINS OF THE FORUM, POMPEII.

BODY OF WOMAN ENCRUSTED WITH LAVA.

A VOLCANO'S DEADLY WORK.

Scenes of destruction as complete and pathetic as these, were enacted at St. Pierre in the French West Indian island of Martinique, as a result of the eruption of Mont Pelée in May, 1902.

that of the autumn of 1904, commencing quietly on September 1, and reaching its maximum on the 25th, has been more violent than any since 1872. Red hot stones hurled 1,600 feet above the cone, have dropped down the flanks of the mountain with deafening sound. One stone thrown out weighed two tons, while 1,844 violent explosions have been

Panorama of Ruins of Pompeii.

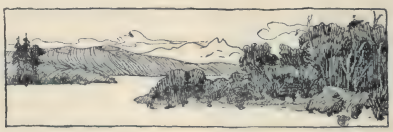
recorded in a single day by the instruments of the seismic observatory.

Observatory Near Cone

This institution has been a scene of activity during the present eruption. It is situated about a mile and a-half from the cone, near the foot of the rope railway ascending that troubled apex. It is a handsome edifice of white stone, and can be seen at a great distance against the black background of lava. It stands on the side toward Naples, on the top of a conspicuous ridge 2,080 feet above the level of the sea. On each side of this ridge flows a river of lava during eruptions; but the building has withstood all, unscathed as yet. An observer is on duty, night and day, even during the most violent outbursts. During that of 1872, when a sheet of red-hot lava glowed on either side of the ridge, and when fiery projectiles fell all about, the post was not deserted. Inside, mounted upon piers penetrating the ground, are delicate instruments, whose indicating hands, resting against record sheets of paper, trace every movement made by the shuddering mountain. One sign by which these great outbursts may almost always be forecast, is the falling of water in the wells of the neighboring villages.

The rope tramway, or "funicular railway," which ascends the great cone from a station of white stone near the Observatory, is now disabled for the first time since it was erected in 1880. Lava from the crater has melted its metal rails, destroyed the upper station, and burned the wooden huts in which the guides at the upper cone have lived. During the three months to be required for the repair of the railroad, all tourists venturing up the cone must resort to the old-fashioned vehicle—the sedan chair carried by porters.

The railway up the smokestack of the fiery furnace is to be rebuilt. But who can say when it may be suddenly blown into the clouds, or when it may fall into the bottomless pit? And—let it be repeated—how soon will the thin ledge beneath the fair City of the Siren give way, offering a tragic theme for a future story, "The Last Days of Neapolis?"



New Sources of Power

Substitutes for Coal—Recovery of Waste Energy—Harnessing Nature's Unused Forces of Sunlight, Wave Motion, Etc.

By GEORGE ETHELBERT WALSH

THE exploitation of possible substitutes for coal reached a maximum of popularity after the prolonged coal strike of two winters ago. Subsequent events, however, have shown that more failure than success attended this spasmodic movement to relegate coal to the background and to substitute some new fuel of equal commercial value. Nevertheless, experiments constantly being made in laboratory and factory are beginning to show permanent results.

The available sources of new energy are of such a diversified character that they naturally fall into classes or groups. There is, first, a group concerned with the recovery of waste gases and heat energy by the invention of mechanical appliances. Second, natural products stored up in the earth, to be utilized directly for heating furnaces and boilers. Third, power which can be extracted from the wind, sun, tides, and river currents by mechanical means, and transformed into electrical energy.

Recovery of Waste Gases—The Gas Engine

In the first group—the recovery of waste gases — we have the remarkable development of the gas engine, which has been constructed to utilize furnace and flue gases as well as the ordinary commercial gas of our cities. The gas engine, a few years ago, was of small unit power, and adapted to only a few uses; but within the past two years engines of this type have been constructed with outputs of 4,000 to 5,000 horsepower. In 1870, gas engines were limited to twenty horse-power, and an engine of 1,000 horse-power was then considered a brilliant dream of the enthusiast.

At first the gas engine could use only high-grade gas, but even with that as fuel it became an important factor in the industrial revolution. Meanwhile the millions of cubic feet of waste gas of blast furnaces and factories were utilized in only a very small way. Efforts were made to burn it under boilers for auxiliary purposes, and air blasts and fans were operated by this method. It was not, however, until the large gas engines were constructed to utilize furnace gases that the problem appeared anywhere near a practical solution. To-day the big blast furnaces are being converted into enormous gas generators, while the manufacture of pig iron promises to become of relatively small importance. To illustrate—a blast furnace capable of producing 150 tons of cast iron a day will furnish 21,000,000 cubic feet of gas. The greater percentage of this enormous gas production was formerly wasted, and represented a fuel that was real and potent for good if it could be recovered and burnt for commercial uses. Possibly half of this gas was available under the old methods, for heating the air blast and for other minor auxiliary purposes. If the other half were burnt in gas engines, 3,500 effective horse-power would be ready for electrical production and transmission. If this same amount of gas were burnt under the boiler for steam purposes, not more than 1,000 horsepower could be obtained.

Blast-furnace gas is comparatively very poor, averaging not more than 27 calories per cubic foot; while some flue and furnace gases are much better, and results are correspondingly more satisfactory.

Recovery of Waste Heat

The flue gases or products of combustion which escape from coal carry from twenty to twenty-five per cent of the heat energy of the fuel up the chimney. There are several methods of recovering part of this heat. Besides the collecting and burning of the gases in specially constructed gas engines, these products of combustion are made to contribute toward the operation of a mill or factory through the employment of fuel economizers. These are placed in the flue in the form of coils or tubes for heating the feed water. About 9.4 per cent of the heat value of coal can in this way be saved. Reclaiming the gases for heating the air before it is admitted to the furnace—which greatly facilitates combustion—represents a further saving of about 7.4 per cent. The recovery of the waste gas for use in the gas engine represents a saving of fully twenty per cent. Thus the waste of heat energy is reduced almost to a minimum.

DIGGING PEAT IN AN 1,800-ACRE BOG.

Possibilities of the Gas Turbine

Now that the merits of the steam turbine have been well established, the best engineers are turning their attention to the development of the gas turbine of large units. Should the gas turbine prove something more than a brilliant dream, we should come pretty close to the final goal—the direct conversion of the energy of coal into electrical energy. The reciprocating gas engine of to-day, designed to utilize waste flue and blast-furnace gases, is the most efficient machine in existence; but the perfect gas turbine would convert the stored energy of carbon into mechanical energy almost directly, and with the least possible amount of waste. This is the dream of scientists, and the goal toward which they are working. It would represent something more precious than the discovery of new coal mines with their millions of tons of stored energy. The saving of waste through the utilization of the last heat unit, is worth more to the manufacturing industries of the world than the discovery of new fuels. Mechanical genius is thus laboring successfully to make amends for any shortcomings of nature in failing to store sufficient fuel for the world's use.

But science is discovering that the world's supply of fuel is not so limited

as earlier judges estimated. The demands upon the coal pile have multiplied rapidly in the past decade of industrial expansion, and the fear of exhausting the supply of fuel has perennially caused some anxiety. The mining of coal is steadily increasing in all parts of the world; but the low grades of bituminous coals, which formerly were little used in this country, are being utilized now so that the consumption of anthracite is not so rapidly increasing. The waste at the coal pile is being abolished also, which represents an item of considerable importance. This is accomplished through the briquetting of the coal dust or culm.

Coal Briquettes

A distinctly new fuel is thus created and brought into common use. In Europe some 22,000,000 tons of coal briquettes are annually produced and used. In America the output of coal briquettes has until recently been almost nothing. The Silesian and lignite or brown coal used for the German briquettes is inferior for steam plants, to the ordinary bituminous coals found so abundantly in the United States. Yet these coal briquettes are burnt with little smoke, and with far better combustion than the soft coal used in American furnaces. The waste attendant upon the burning of raw bituminous coals in steam plants is so great that special machinery has been invented to recover a part of it.

Thus we have machinery constructed to briquette flue dust in the larger factories. The immense amount of soot and dust that goes up the chimney from soft coal, represents imperfect combustion of a high order. This accumulates in flues and chimneys, and clogs them so that frequent cleaning is necessary. Machinery for scraping the flues, and collecting the flue dust for briquetting purposes, has of late been in successful operation. The dust is carried away to hoppers, and mixed with a binder containing certain percentages of lime, soda ash, salt, and pitch. The compound is hydraulically pressed into briquettes of convenient size. When dried properly in ovens, the briquettes furnish a high grade of combustible fuel, which burns better, and gives a more uniform heat, than raw soft coal.

The waste flue dust of our factories represents from ten to fifteen per cent of the total amount of soft coal consumed, while the culm of coal dust of the anthracite mines represents five per cent or more of the total production of hard coals. The utilization of both wastes through briquetting them in commercial forms, diminishes our extravagant use of fuel, which for years has been an American sin. Europeans have decried our waste of coal as much as our foolish waste of wood and timber. In both cases we are gradually coming to a reforming sense of our guilt, which will immeasurably add to the manufacturing wealth of the country.

The briquetting of *waste material of all kinds that can be burnt under the furnace* represents an economy in fuel practice of considerable importance. In our cities the garbage that is now incinerated to produce steam must be burnt with other fuel to produce good combustion. It is a question whether this waste material could not be briquetted so that it would prove of commercial value. At present it is burnt at low commercial returns.

Carting Peat to the Converter.

The Use of Peat

The use of peat for fuel is a more important question in this country than that of briquetting city waste, for it has been clearly demonstrated that peat can be extracted and compressed in commercial forms at less than one dollar a ton in cost. Briquetted peat has been used for furnace and stove purposes since 1859; but in this country little attempt until recently has been made to utilize this fuel. There are extensive deposits of peat in the East and West that have a higher combustible quality than much of that used in Europe. Wisconsin, Minnesota, and Michigan have enormous peat bogs containing from fifteen to twenty-five per cent of combustible material. Fully 80 per cent of the bog is composed of water, which when extracted leaves a highly concentrated fuel. In the West, peat extracting and compressing plants, chiefly experimental, are now in operation.

All through New England and New Jersey there are peat bogs, which contain, according to scientific estimates, as much heating power as the Pennsylvania coal mines. In parts of New England the beds extend to a depth of thirty feet, growing richer and more valuable at the greater depths. This peat can be dug out and used when dry, in its crude form; but to prove of commercial value it has to be compressed. Canada likewise has extensive peat bogs, and several plants are in operation there in preparing it for market. This great natural supply of a new fuel promises to prove a formidable factor in regulating the price of coal in the near future. In Germany, peat briquettes sell from $2.50 to $4 per ton. The ash of the peat fuel represents seldom more than 4 per cent. This fuel does not cause any deposits of clinkers, nor does it leave any slag behind. When thoroughly heated, it glows at a white heat until fully consumed. In parts of Europe, peat is now being converted into coke on a large industrial scale. It is also used for making tar products, methyl alcohol, acetate of lime, and sulphate of ammonia; but these are chiefly by-products, and are extracted after the heat energy has been used for power purposes. In Russia about 4,000,000 tons of peat is mined and burnt annually; and in Germany, about 2,000,000 tons. Throughout the rest of Europe, from five to six million tons is used. Yet

PLACING PEAT IN THE SUN TO DRY.
The peat comes from the converter in rolls like these, but contains an excess of water, which is removed by sun-drying.

SOLAR MOTOR FOR PUMPING WATER ON OSTRICH FARM NEAR PASADENA, CAL.
A type of machine in use in Southern California and Arizona. By means of the mirrors on inner side of umbrella-like reflector, the sun's rays are concentrated on the boiler shown in the central framework. The device is self-focusing, by means of clockwork machinery.

in America the peat bogs are larger and richer than in any country of Europe, and the amount of heat energy locked up in the bogs exceeds that buried in coal mines. For the capitalist and scientist who can first establish a monopoly of peat briquettes, there certainly awaits a fortune scarcely measured by seven or eight figures.

Petroleum and its Products

The next natural raw product which falls under the second group of new fuels, is petroleum, with all its by-products and derivatives. Crude and refined petroleum are employed to-day for operating machinery, to an extent never dreamed of ten years ago. The perfection of the crude petroleum or kerosene oil engine is a present-day accomplishment. The low-flash oil can be burnt in these engines without danger, and at small cost of operation. The engines are coupled directly to electric generators; and, without the need of boilers for water or innumerable other parts of the steam engine, there is a decided economy of practice. In parts of the country where both water and coal are scarce, crude petroleum engines have been the means of building up industries never before considered possible.

The perfection of oil furnaces, which enables the manufacturer in all parts of the country to burn oil alternately with coal or alone, has been realized within the past two years. The oil is delivered to the burners installed in an ordinary furnace, and is sprayed by a jet of steam so that when ignited every part of the fluid is consumed. There is no waste through imperfect combustion or by leakage. A furnace designed for using coal and oil fuel, guards against coal-strike troubles and excessively high prices for coal. The manufacturer can quickly change from one fuel to the other. Oil is cheaper for fuel purposes on the Pacific coast, in Texas, and in many of the other Southern and far Western States; but on the Atlantic seaboard it has not yet demonstrated its economy over coal except in the matter of handling, storing, and equipment of the furnaces. On the Pacific coast, crude oil has been so cheap that its use for power production has enabled it in places to compete with power transmitted from water-power stations.

Fuel oil as an auxiliary is now used in hundreds of factories and mills all over the country. At one dollar a barrel it can be burnt with economy; but its increasing use is gradually tending toward higher

BOILER OF SOLAR MOTOR.

Power is conveyed from the boiler to the engine through the irregular steel pipe shown in the picture, which is built in sections. This pipe is an English invention of great value.

prices. In 1901, the average price paid for the 69,000,000 odd barrels produced in this country, was 95.7 cents per barrel, against an average of $1.19 in 1900. This decrease was due to the sudden exploitation of the new Texas and California oil regions. The increased demand for oil as a fuel is now slowly driving prices up to a point where it cannot enter actively into competition with coal as a fuel for power production. However, for special purposes where oil engines are employed for driving electric generators, crude and refined petroleum have come to stay as economical fuels, and their use will continue to increase. Like gas for the gas engine, crude oil is a fuel which, when burnt in the oil engine, has advantages that more than compensate for any difference in cost of the crude product. The present production of oil in the United States averages 70,000,000 barrels a year, and there is little present indication that this amount will be materially decreased in the near future. The supplies of mineral oil are not inexhaustible, but there are outcroppings of oil rocks in many parts of the country which furnish scientists with basis for their belief that there will never be an oil famine in this country. Even the older oil regions, instead of being exhausted, are worked to-day with renewed activity because of the invention of new and more powerful pumping machinery for reclaiming the oil from its underground beds. In the Northwest and in parts of Canada, new oil regions are constantly being discovered, while there are favorable locations where underground deposits of it should exist in great quantities if geological formations are trustworthy criteria.

The total valuation of the petroleum output of this country is placed by the United States Geological Survey at approximately $75,000,000 per year. Of this amount, a large percentage is exported. In California and Texas, oil sells as low as 40 to 75 cents per barrel, making it the cheapest fuel on record. If nothing else, oil has accomplished the excellent result of keeping coal from soaring to prohibitive prices; and the discovery of every new fuel works toward the same beneficent end.

Action of Wind, Sun, Streams, etc.

In the last group of power sources, we have heat produced by the action of wind, sun, tides, and river currents. These furnish speculative dreams for the scientist which are almost daily being realized by some actual accomplishment. For centuries the wind has been harnessed for pumping water for irrigation purposes, but in recent times it has been utilized for driving electrical generators and dynamos. In parts of the arid West, wind-

SOLAR MOTOR FACING SUN AT MIDDAY.

mills have been successfully employed for this purpose.

What seems even more wonderful is the harnessing of the sun to do man's work. The heat energy of the sun's rays is great, and, when focused upon a single point, it is sufficient to raise water to the boiling point. Solar motors have been successfully operated in Europe and on the Pacific coast. Large burning glasses or reflectors are used for concentrating the rays on a small boiler surface, where the heat imparted is sufficient to boil water. The need of a solar motor is greater in hot, dry regions where mechanical power is needed for mining, manufacturing, or agricultural purposes. In Southern California, where the sun shines almost continuously the year round a solar motor has been in operation for several years. The reflector is a huge disk of glass 33 feet in diameter at the top and fifteen feet at the bottom. Inside of this reflector there are over 1,700 small mirrors, all arranged so as to concentrate the sun's rays upon a central or focal point. At this point is located the boiler, which holds 100 gallons of water and has room for eight cubic feet of steam. Within an hour after the sun's rays are focused on the boiler, the register shows 150 pounds' pressure of steam. The motor pumps water as successfully as any engine run by coal or fuel. It lifts 1,400 gallons of water per minute, or shows a working force of from ten to fifteen horse-power.

The harnessing of tides and currents of rivers and bays needs no description, for, since Niagara was made to work for man, scores of lesser streams have been harnessed, and their waste power converted into electrical energy. In California the mountain streams have been thus enlisted to do man's bidding, and the longest electrical transmission in the world successfully accomplished. The great Central States have built up new industrial conditions through the employment of waste water power; and along our Atlantic shore there are promised groups of new industries entirely dependent upon electric power derived from the waves and tides of the ocean and its tributaries. In the Niagara district, new industries have been created through the use of cheap electrical power of large current, and in the aggregate they represent a capitalization of hundreds of millions of dollars. Where electrical energy derived from water power will ultimately end, no one can predict to-day; but it is rapidly solving one branch of the fuel problem.

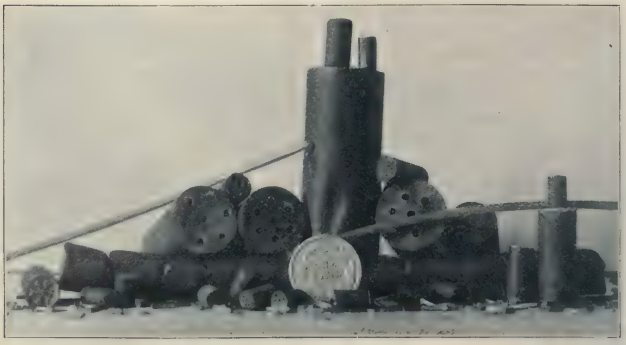
PHOTO BY AYDELOTTE, SANTA CRUZ, CAL.

WAVE MOTOR IN OPERATION ON COAST NORTH OF SANTA CRUZ, CAL.

Invented by E. J. Armstrong. Two wells, open to the ocean at the bottom, are sunk in the cliff to below low-water mark. In one, a counterbalanced float, rising and falling with the waves, operates a force pump plunger in the other well, which is capable of driving a 4-inch stream to the 5,000-gallon tank standing 125 feet above. In ordinary weather the pump fills the tank in an hour; in stormy weather, in 35 minutes.

The sources of new fuels are thus so great and extended that the fear of an industrial panic through high cost of power production has little foundation in fact. Not even the exhaustion of our coal mines in the next fifty years, could turn out the fires and lights of our great industrial plants. Before such a condition could be realized, the sun, wind, tides, and new raw fuels of the earth would be abundantly able to turn every wheel of commerce, and supply us with all the heat and light we needed. As a storehouse of heat energy, the world is beyond compare, and its exhaustion can never be brought about so long as chemical action and affinity are existent laws of the universe.

SAMPLES OF ALL SIZES OF SMOKELESS POWDER USED BY THE UNITED STATES NAVY.



Smokeless Powder

Details of Its Manufacture as Conducted at the Government Naval Powder Factory, Indian Head, Maryland

By ROBERT G. SKERRETT

Formerly of the Navy Department, Washington, D. C.

BECAUSE of required brevity, the history of the invention and the development of smokeless powder must be omitted from the present article, dealing, as it does, only with the manufacture and not with the evolution of the propellant. To the inquiring, enough is said in pointing out that the invention of gun-cotton and the practical development of its manufacture are at once the origin and the foundation of the smokeless powders of to-day.

A Recent Development

Our war with Spain brought us seriously face to face with the need of a change, for the smoke of our guns, apart from obscuring our aim, made just the tell-tale mark the foe needed whereby to check his range that he might pick off our men otherwise screened from view. At that time—in 1898—smokeless powder was manufactured in the United States in only very modest quantities, and the character of that little output had not been officially proved to be all it should be. Before the war was over, a part of the fifty-million-dollar defense fund was turned to the beginning of a Naval Powder Factory at Indian Head; and, under the energetic direction of Rear-Admiral O'Neil, Chief of the Bureau of Ordnance, active preparations

A 10-INCH COAST-DEFENSE RIFLE IN ACT OF DISCHARGE. USING NON-SMOKELESS POWDER.

A typical example illustrating value of the smokeless variety of propellant.

Photos copyrighted, 1904, by R. G. Skerrett.

along this line were promptly made. It was not, however, until July of 1900, that the first grains of the new explosive were turned out. Since then, the original plant has from time to time been amplified, until now the establishment turns out many tons a month.

ing in weight—implying, in turn, that a ship could, on a given weight, carry just so many more potential blows for an enemy—such a change would mean greater ease of handling, greater range for the gun, and much less stress upon the weapon for a given result, together

WASH HOUSE, WHERE THE COTTON IS FIRST CLEANSED BEFORE NITRATING.

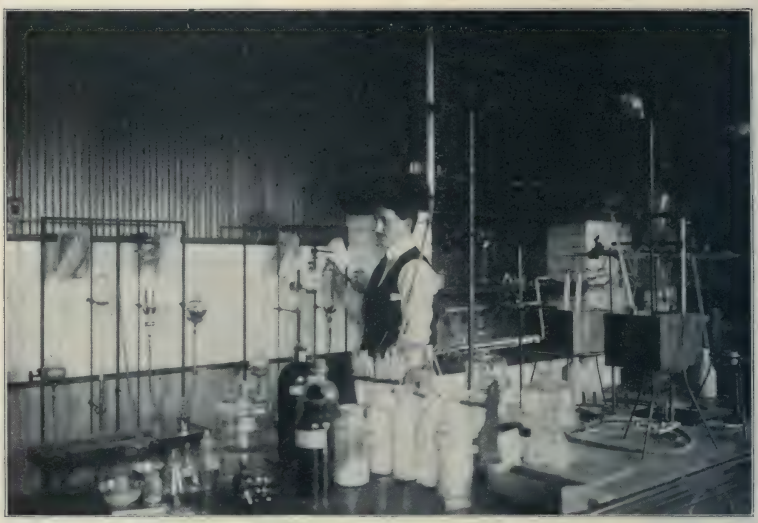
The Rationale

The smokelessness of the modern powder is the consequence rather than the direct aim of certain ends for which the chemist and the ordnance engineer were working. Smoke, as every one knows, is evidence of incomplete combustion; and, when the old black or brown powders were used, but a trifle over one-third of their bulk was consumed in the generation of propelling gases: the two-thirds remaining were represented in smoke and inert or ineffective residue, which, together with the projectile, had to be driven out of the gun by the effective or active one-third. In other words, could the chemist find a properly combustible propellant—one that would be regularly and completely consumed within the gun—one pound of such an ideal powder would in effect be nearly equal to three pounds of the old brown or black powders. Apart from this saving with absence of the fouling common to all smoky powders. The solution of the puzzle lay in the adaptation of gun-cotton as a basis for a new propellant—the substitution of a homogeneous substance for the mechanical mixture of the past.

Gun-Cotton the Basis

Gun-cotton, as most of us know, is the cotton of commerce made explosive by soaking it in a mixture of nitric and sulphuric acids, and then, by subsequent mechanical treatments, made into one of the safest and at the same time most powerful of explosives.

The propellant used in our Navy's ordnance is what is technically known as a "gun-cotton powder;" but the term "powder" is decidedly a misnomer, the units being perfectly-formed grains of varying size instead of the shapeless particles characteristic of a "powder" properly so called.



TESTING PYRO IN LABORATORY.

Soluble gun-cotton is that containing less than 12.75 per cent of nitrogen. This, when treated in a mixture of ether and alcohol, becomes a jelly-like substance which, after the solvent has been withdrawn or dissipated, becomes a hard, tough, translucent mass. Pressed into the form of grains, this substance will burn regularly and without smoke. It cannot be detonated by shock, and requires an ignition temperature of 185° C., which, while lower than that of the old powders, is misleading, for the substance is really less inflammable than the latter, and actually requires a starting or ignition charge of black powder. The small amount of smoke now seen at the time of discharge of our guns, is due almost entirely to the ignition charge of black powder.

Processes of Manufacture—Nitration

So much for the reasons and the results. Now for the manufacture. Cotton-seed waste, lint cotton, and card waste, after a proper cleansing in a caustic bath, and a thorough drying, are the materials used. This stuff is soaked for half an hour in a mixture of sulphuric and nitric acids—one pound of cotton to fifty pounds of acid mixture. During nitration, a certain percentage of water is liberated, which, if not absorbed, would weaken the nitric acid and gradually lower the degree of nitration. The mission of the sulphuric acid is to absorb the water and thus maintain the strength of the nitric acid at its proper standard. The strength of the acid mixture, its temperature, the duration of the soaking, the initial dryness of the cotton, and even the condition of the minute mass of fibers as to their agglomeration, all bear directly upon the resultant product, both as to its nitration and as to its solubility. The nitration takes place in a centrifugal wringer, which, after the proper period of quiescence, is put in motion and drains the bulk of the acid from the mass. After this, the gun-cotton—for such it has become—is put in a large tank and washed or "drowned" in fresh water, and after that again washed in fresh water in another centrifugal wringer.

Every effort is now made to remove the least trace of residual acid, for it is this that most affects the stability or keeping qualities of the subsequent so-called powder. To this end, the gun-cotton is put into large vats and boiled for a couple of days, during which several changes of water are made. After this, the material is put in pulping machines

just like those used in a paper mill, where it is ground for fifteen or twenty hours, the water again being continually changed, and sodium carbonate added from time to time to neutralize any free acid still remaining in the cotton. From the pulpers, the cotton or pulp is moved to big, circular vats called "poachers," and is then steamed and stirred for a period of forty-eight hours. Fresh water is added frequently, and, after a proper time, the mass is allowed to settle and the top water drained off. By successive washings, settlings, and drainings, all traces of alkali are removed, and the pulp is then tested by heat for stability.

Mixing

The pulp must now be thoroughly dried and all water removed before subjecting it to the ether-alcohol. Large centrifugal wringers remove 75 per cent of the water; after which the pulp, like a thick paste, is fed onto a wide blanket belt and led through rollers that turn out the "pyro," as it is called, in flakes which feel not unlike slightly dampened crackers. In this flaky condition, the "pyro" is carried to the dehydrating press. Into the cylinder of this press is put fifty pounds of the damp cotton; and, under a pressure of 200 pounds per square inch, the major part of the residual water is forced out, the material being at the same time formed into a compact cylindrical mass. The piston is withdrawn; twenty-five pounds of alcohol is poured in, on top of the cotton; the cylinder is closed; and air, under a pressure of 100 pounds, is turned in, on top of the alcohol. The result is that the alcohol is forced through the mass, driving the water before it. After most of the alcohol is out, which is not until the cotton has been subjected to a further pressure of nearly 3,000 pounds to the square inch, the remaining 25 per cent leaves the cotton in just the proper condition for the admixture of ether, which is added to the amount of half the weight of the mass, to provide the proper solvent.

In order to insure a thorough mixing, the cotton is next put in a "mixer"—the double of the mechanical kneader used in steam bakeries. There, after an hour, the solvent becomes thoroughly mixed with the cotton, and the mass looks and feels like damp, coagulated corn meal. From the mixer, the material is put into a press, and is formed into cakes weigh-

THE DEHYDRATING PRESSES.

ing about fifty pounds each. To the touch it is like crude rubber, and in appearance looks not unlike syrup-soaked maple sugar. Technically, the substance is now termed "colloid," and it actually is smokeless powder; but there are still a number of processes to be gone through before the material becomes the completely finished product.

To make sure, however, that the solution is complete, the rubbery mass is forced through a thick steel strainer under a pressure of two and a-half tons. It comes out in long cords of a pale straw color, and, with the exception of a central hole, looks not unlike macaroni. This, again, is packed back in the press, and squeezed once more into the form of a large, rubbery cylinder—the color, however, having become uniform throughout.

POWDER PRESS.
Showing the colloid coming out in long rods.

Making the Grains

The mass is now ready to be made into grains. This time the press has only one opening, and that is of the size of the desired grain. Into this opening is fitted an ingeniously constructed die, into which are set as many fine wires—one end of each wire being free—as there are to be perforations in the grain. The colloid is now forced through this die, backed by a pressure of from 4,000 to 6,000 pounds, depending, of course, upon the size of the grain. The colloid comes out in a continuous rod like an interminable, pale yellow snake, with a number of symmetrically disposed longitudinal perforations. As this rod passes to the end of the table or trough, it is run into a "cutter" which clips off the grains in proper lengths. The object of the longitudinal perforations is to admit the flame to the interior of the grain, so that, as the exterior decreases under the attack of the gases, the interior surface of attack increases. The result is the maintenance of a uniform total area of combustion, and a consequent uniform development of propulsive gases. The result of this, in turn, is that the shot, during its run from breech to muzzle, receives a gradual increase of velocity as its inertia is overcome, and leaves the weapon with a much higher velocity than it is possible to secure on a given weight, with safety, by using black or brown powder—the rate of burning of which is either spasmodic,

as in the case of the black, or only relatively regular, as in that of the brown variety of the older propellants.

Drying

After the colloid has been made into grains, the next steps are devoted to drying it. The first of these processes is one of economy. At this stage the powder retains a large percentage of the solvent ether-alcohol, and to recover this is important. This is done by heating the powder, and reclaiming the volatile solvent by condensation. After this, the powder is put in drying houses, where the temperature is maintained uniformly throughout long periods. For the large-sized grains, it takes about six months to dry out all but about 3.5 per cent of the solvent. During the process of drying, the grains change in color from a pale yellow to a deep golden brown, and by the time they are used in service the color is even darker.

Testing

At various stages of the manufacture, the chemist steps in and most careful analyses are made. Even after the powder has passed all these tests, a sample lot is stored away in a surveillance magazine, where, day by day, it is watched, and, should it be found lacking in stability, the ships carrying it are at once so informed and proper measures of safety taken. This, however, owing to the thorough and careful methods of governmental manufacture, has not been necessary for a long time.

That the powder is uniform in its working, must be determined by firing tests, in which the developed pressures are carefully checked; this is one of the duties devolving upon the United States Naval Proving Grounds, and the details of the work must be reserved for treatment in a separate article.

Smokeless powder, even with the improvement it represents over the old propellants, brings with its use its own problems. One of these, as we have seen from the recent accident on the battleship *Missouri*, is based on the presence of residual gases in the gun after discharge, and the danger of their ignition on the opening of the breech and the admixture of oxygen. The size and the shape of the grain have much to do with these difficulties; so too—and intimately—have the number and character of the longitudinal perforations; and all of these are under constant examination and study at the Naval Powder Factory.

Examining Powder in Process of Drying.

A National Enterprise

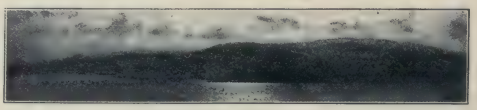
When the government factory was established, there was a howl from the private manufacturers of powder; and, as the plant has increased, these private interests have persistently opposed it, but Congress has continued the necessary appropriations.

The economic results of the establishment of the plant have been many. The price of manufacture by private concerns is declared to have been unreasonably high—making due allowance for all business interests—and the Government demanded and secured a reasonable reduction. The quality of the product is maintained, and all of it chemically and ballistically tested, both that manufactured at the government plant and that made by private manufacturers. Moreover, improvements have been discovered and initiated, which private enterprise might

never have unearthed or put into effect.

Running, as the government powder plant does, night and day, year in and year out, still the output is but a modest part of the total quantity of powder annually consumed in target practice. The vast bulk of the propellant used is manufactured by the great powder works of the country. The result is, that, while the government plant has become an invaluable check and a means of exhaustive research and scientific experimentation, private enterprise has in no way been injured, and the welfare of the nation is the better safeguarded against the day of stress and conflict.

It is hard to believe that in the snowy wealth of our peaceful cotton fields lies in potentiality the dreadful blast of our mighty ordnance.



The Best of Life

NOT till life's heat is cooled,
The headlong rush slowed to a quiet pace,
And every purblind passion that has ruled
Our noisier years, at last
Spurs us in vain, and, weary of the race,
We care no more who loses or who wins—
Ah! not till the best of life seems past,
The best of life begins.

To toil for only fame,
Handicappings, and the fickle gusts of praise,
For place or power or gold to gild a name
Above the grave whereto
All paths will bring us, were to lose our days,
We, on whose ears youth's passing bell has tolled,
Forgetting we grow old.

But the world widens when
Such hope of trivial gain that ruled us lies
Broken among our childhood's toys; for then
We win to self-control,
And mail ourselves in manhood; and there rise
Upon us, from the vast and windless height,
Those clearer thoughts that are unto the soul
What stars are to the night.

—*The Spectator.*

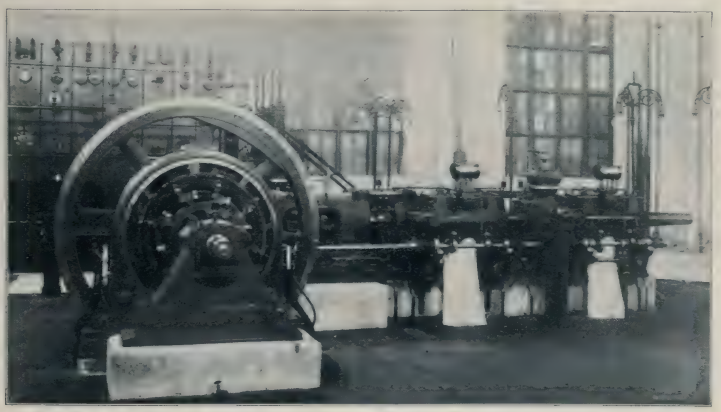
Possibilities of the Gas Engine

A Comparison of the Steam and Internal-Combustion Engine as to Economy and Efficiency

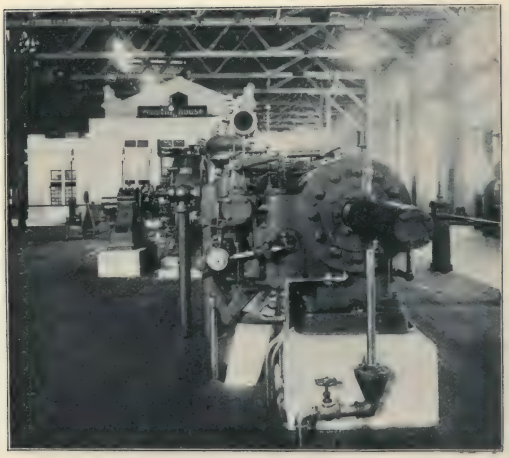
By DAY ALLEN WILLEY

IN the recent evolution of various types of machines for the development of power, it is questionable if even electricity or compressed air—or even the much-talked-of steam turbine—has aroused greater interest among mechanical and economic experts than the gas engine as manufactured to-day. While found in more common use in Europe than in America because of the high cost of steam fuel, this type of mechanism has been sufficiently tested by practical operation in the United States to prove its great value. In fact, such has been the progress made in this country in designing gas engines, that machines of this type are now manufactured which develop no less than 4,000 brake horse-power.

The gas engine does away entirely with the boiler house, and transforms over 25 per cent of the heat energy of gas into useful work at the shaft; whereas the efficiency of an ordinary high-grade condensing steam engine is seldom found to be more than 12 or 13 per cent. As modern gas processes have been brought to such a state of efficiency that 80 or 85 per cent of the original heat value of coal appears in producer gas, whereas a boiler efficiency of 70 per cent is regarded as high in steam practice, the basic superiority of the gas engine over the steam engine in high fuel economy may readily be appreciated. The gas engine's special advantages are not alone a minimum fuel and heat consumption, and the elimination of boilers, steam pumps, condensers, return traps, and other steam plant auxiliaries, and of the heat losses and leakage from such auxiliaries, both when the steam engine is in operation and when it is shut down. It has special fields of service, also, in the effective utilization for power purposes of millions of horse-power of blast-furnace



SIDE VIEW OF 225-H. P. HORIZONTAL DOUBLE-ACTING WESTINGHOUSE GAS ENGINE DIRECT-CONNECTED TO 3-WIRE DOUBLE-VOLTAGE DIRECT-CURRENT GENERATOR.



End View of 225-H. P. Horizontal Double-Acting Westinghouse Gas Engine.

gas daily going to waste in the mills of the world, or consumed to poor advantage in the production of steam power; in the operation of high-pressure water-pumping systems for city fire service, wherein it is not economically practicable to maintain constant steam pressure, with service required at only rare intervals; in the equipment of central electric lighting plants operated in connection with large gas works; and in general power application wherever natural gas is abundant.

As already intimated, the efficiency and economy of this type of power generator have been demonstrated beyond question. One series of tests may be cited as an illustration:

A two-cylinder vertical engine of 65 horse-power was kept in operation for 1,157 hours without stopping, and then it was shut off to permit replacing a broken belt. Out of a period of 8,472 hours, it was in motion 8,230 hours. During the time when work was suspended, necessary repairs were made; but these were so slight as to require but 40 hours in all.

In another instance, the performance of a 1,250-horse-power steam station having compound-condensing engines, and a gas engine station of 650 brake horse-power, was compared. The coal used was purchased at the rate of $4 per ton for both stations. It was found that the gas engines, which were of the Westinghouse pattern, could be operated at a saving of 45 per cent in the cost of fuel alone compared with steam, yet performing the same service.

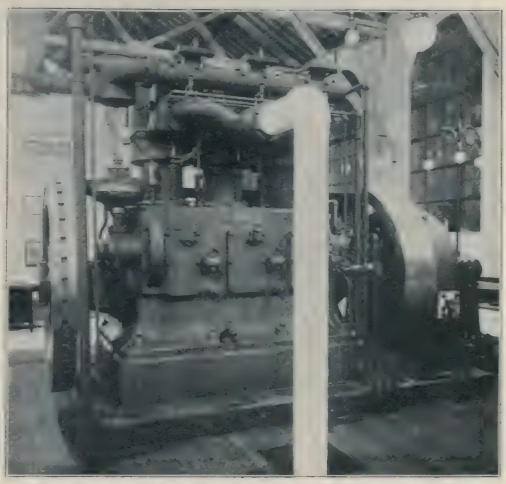
Some of the most advanced types of gas engines operate on what is known as the four-stroke cycle. The piston draws in a mixture of gas and air on the forward stroke, and compresses it to a high degree within the clearance space on the return stroke, whereupon it is ignited by an electric spark. The pressure resulting from the expansive force of the rapidly burning gas mixture drives the piston forward, and the exhaust valves open at the end of the stroke for the escape of the burned gas; while the piston, upon the fourth or exhaust stroke, completely cleans the cylinder, thus preparing for a new charge of gas and air.

This cycle of operations is repeated in each cylinder. In single-acting engines, pressure is exerted upon only one side of the piston; in double-acting engines, it is exerted upon both sides. The double-acting arrangement is peculiarly adapted to the driving of large electric generators, especially alternating-current generators working in synchronism upon the same supply circuit.

The accompanying views are of some of the more interesting types of Westinghouse gas engines which were in service at the World's Fair. One is a double-acting engine having a rated capacity of 200 brake horse-power, while the other is a three-cylinder engine. It will be noted that the double-acting engine has its two cylinders arranged tandem with a common piston-rod, so that the engine gives one power impulse at each forward and backward stroke, as in a steam engine. It operates at a speed of 200 revolutions a minute. The cylinders are 14½ inches in diameter and the length of stroke 22 inches, the maximum diameter of the shaft being 9¾ inches and the diameter at the bearings 7½ inches. The length of the unit over all is 27 feet 4½ inches; and the width, 13 feet 3 inches. The engine is 7 feet wide, and 8 feet 2 inches high, the fly-wheel diameter being 8 feet

9 inches. Ignition may be by storage battery, primary battery, or motor-generator set. Because of the tandem arrangement of the cylinders, the fly wheel of the double-acting engine is lighter than that necessary in the single-acting type. Piston and piston-rods are hollow in order that cooling water may be circulated through them, the water entering at the cross-head through a telescopic joint, and emerging through the "tail rod" at the rear of the engine. The starting is a simple matter, readily accomplished by one attendant; and as soon as the engine is fairly started, the combustion cycle begins in the forward cylinder, the air is shut off, and the rear cylinder is thrown into service. Lubrication of the internal working parts, one of the most difficult problems of the internal-combustion engine, is automatically performed by small-power oil-pumps driven from the cam lever.

The three-cylinder vertical gas engine has a rated capacity of 125 brake horse-power, and operates at a speed of 265 revolutions per minute. The cylinders are 13 inches in diameter; and the length of stroke, 14 inches. The maximum diameter of shaft is 7½ inches, the diameter at bearings being 6½ inches, and at outboard bearings 5¼ inches. The length of the unit over all, including fly wheel, is 17 feet 3⅞ inches; and the width 6 feet 9 inches. The engine is 4 feet 4 inches wide, over all; and 10 feet 4¾ inches high, the fly-wheel diameter being 6 feet.



A 125-H. P. Single-Acting Gas Engine, Westinghouse Design.

The principal difference in construction from that of the horizontal engine, apart from the different arrangement of cylinders, is in the employment of the single-acting principle, in which only the upper side of the piston receives the pressure of the expanding gases. A long-trunk piston is, therefore, employed, thus dispensing with the cross-head. The distinguishing characteristic of the vertical engine is its self-contained construction, all the main moving parts being enclosed in a cast-iron casing, which is filled with oil up to the shaft, the cranks during their revolution dipping into this oil and furnishing splash lubrication to all internal parts, including connecting rods, pins, and cam shaft, the latter also being mounted inside the crank case.

The performance of the vertical engine is approximately the same as that of the horizontal type, when proper consideration is given to the difference in size and construction, the same working cycle being employed in both types. The generator, which was direct-connected to the vertical engine, had a rated capacity of 75 kilowatts, direct current, at 125 volts. It had six field poles, compound-wound; and weighed 8,350 pounds.

ELECTRICALLY-DRIVEN CANTILEVER TRAVELING CRANE SERVING STORAGE PLANT FOR ORE, COKE, AND COAL.

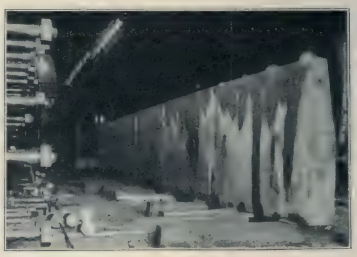
Modern Armor-Plate

Its Manufacture as Carried on at the Plant of the Bethlehem Steel Company South Bethlehem, Pa.

By FRANK C. PERKINS

ONE of the largest manufacturing plants in the U. S. where armor-plate is made is that of the Bethlehem Steel Company at South Bethlehem, Pennsylvania. The works cover an area of nearly 200 acres, and include blast furnaces, puddling mills, Bessemer steel converters, open hearth furnaces, and hydraulic forge press shops, as well as tempering and treating departments, all of which are equipped with the latest labor-saving devices.

The storage plant for the blast furnaces covers a very large area, and is served by an enormous traveling cantilever crane electrically operated. The ore, coal, and coke are delivered by the railroad cars to this crane, the material being dumped from the car through chutes into the bucket, and then simply stored in piles until required at the furnaces. The storage capacity of the plant is about a third of a million tons. The blast-furnace equipment comprises five furnaces 70 feet high, with 10-foot hearths and 16-foot boshes. Horizontal-compound blowing engines are provided, capable of blowing a pressure of 20 lbs. of air, these engines being supplied with steam by boilers fired with the waste gases from the furnaces. The furnaces are provided with fire brick regenerative



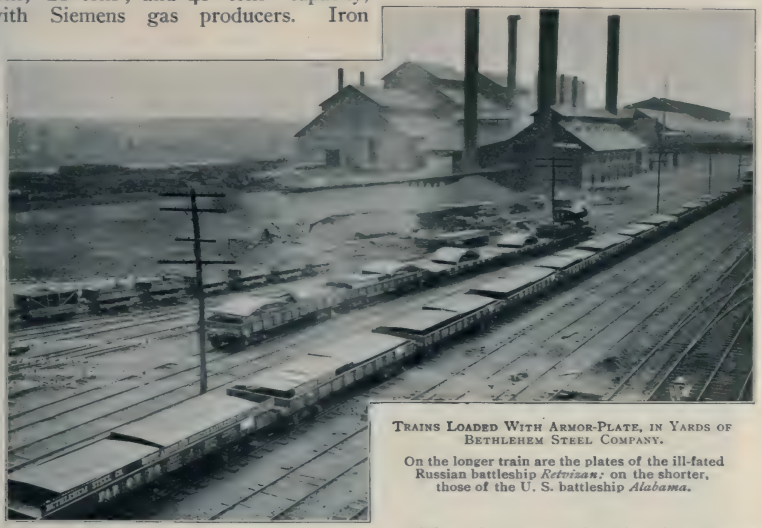
NICKEL-STEEL SIDE ARMOR-PLATES OF RUSSIAN BATTLESHIP "PETROPAVLOVSK."
Height, 7 ft. 8 in.; thickness, 16 in., tapered to 8 inches; weight, 140.04 tons.

stoves of the Siemens-Cowper-Cochrane type, 18 feet in diameter and 60 feet high. The flux, as well as the ore and fuel, is hoisted and fed to the mouth of the furnace in successive layers, the flux being limestone, the fuel coke and anthracite coal, and the ores hematites and magnetites.

The stock yard for the open hearth furnaces is served by three electric traveling cranes of 20 tons' and 60 tons' capacity. The materials are received on elevated railroad tracks, and piled preparatory to sending to the furnaces. There are 11 open hearth furnaces of 10 tons,' 20 tons', and 40 tons' capacity, with Siemens gas producers. Iron boxes are used for delivering the stock to the charging floor. These boxes are loaded on narrow-gauge carriages; and electric charging machines, together with a 25-ton electric crane, are used in charging the furnaces.

To handle the molten metal, immense ladles are provided, which run on tracks, the molten metal being packed into these ladles and from them into the moulds of the size required for casting the steel armor-plate ingots. These ingots are allowed to cool in the moulds for one or two days. Their removal from the moulds is accomplished by the aid of several electric and pneumatic cranes of from 25 to 75 tons' capacity. Some of the nickel-steel armor-plate ingots weigh as much as 122 gross tons, although the plate when finished with portholes cut out weighs only 27.6 gross tons.

After being heated, the armor-plate ingot is forged to the required dimensions by a forging press having a capacity of 14,000 tons, this press being served by combination hydraulic-pneumatic cranes of 200 tons' capacity, having a hydraulic lift and pneumatic travel. Exclusive of counterweights used, the Porter bar and chuck which holds the plate for forging weighs nearly 65 tons.

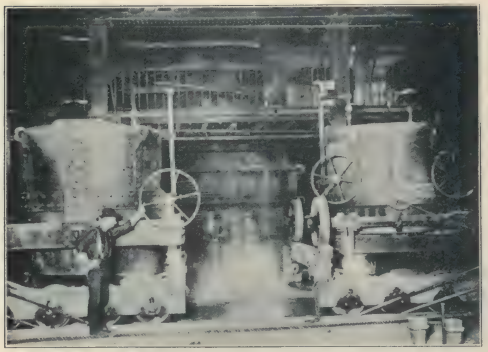


TRAINS LOADED WITH ARMOR-PLATE, IN YARDS OF BETHLEHEM STEEL COMPANY.

On the longer train are the plates of the ill-fated Russian battleship *Retvizan;* on the shorter, those of the U. S. battleship *Alabama.*

After the armor-plate has been roughforged to size and reheated, it is sent to the bending press to be straightened or bent to shape. In the case of a conning tower, for example, the carbonized plates are bent to a circle having a radius of 38 inches. The bending press exerts a hydraulic thrust of 7,000 tons, and has two independently operated plungers. This press is served by two hydraulic cranes of 75 tons' capacity, and by direct-fired furnaces with movable car bottoms.

The armor-plate machine shop at the Bethlehem steel plant is equipped with very large machine tools and the latest labor-saving devices. In this shop the various groups of plates, before being



LADLES AT OPEN HEARTH FURNACES.

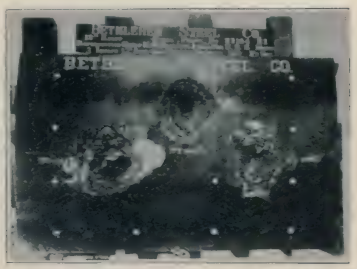
shipped, are assembled for final inspection, in the positions they will occupy on the vessel. The accompanying illustration shows loaded on the shorter of the two trains, the Harveyized armor-plates for the turret of the U. S. battleship *Alabama,* which weighed 166 tons, the thickness of the plates being 14 inches; also, loaded on the longer train, 34 side armor-plates for the Russian battleship *Retvizan,* this Krupp armor being 9 inches thick and weighing 500 tons. The barbette for a 13-inch gun turret on the U. S. battleship *Indiana,* constructed at the Bethlehem plant, consisted of 13 plates weighing 406 tons. These plates are 17 inches thick, the size of the barbette being 12 feet 1 inch by 34 feet 7 inches. The nickel-steel plates for the side armor of the Russian battleship *Petropavlovsk* were made to taper in thickness from 16 inches to 8 inches, and were 7 feet 8 inches high, the weight of the plates shown in the accompanying illustration being somewhat over 140 tons.

Armor-plate manufactured at the present time receives very severe tests, as may be seen from the accompanying photographs. A nickel-steel oil-tempered ballistic plate was tested with three shots from an 8-inch gun, the projectile weighing 250 lbs. and having a velocity of 1,400 foot-seconds, the energy being 3,400 foot-tons. The penetration was 10½ inches and 11 inches, the plate being slightly bulged. The size of this plate was 136 inches by 91 inches.

The Kruppized steel ballistic plate seen in the accompanying illustration was also tested with three shots, a 12-inch gun being used. This plate was 151½ inches long by 97 inches wide and 12 inches

ARMOR-PLATE MACHINE SHOP.

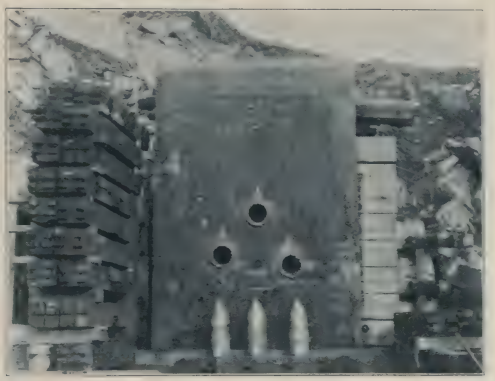
BARBETTE FOR 13-INCH GUN TURRET ON U. S. BATTLESHIP "INDIANA."
Comprises 13 plates, weighing 406 tons.



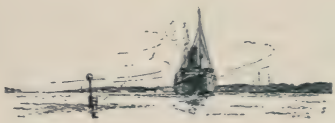
A 12-INCH KRUPPIZED STEEL BALLISTIC PLATE TESTED WITH THREE SHOTS FROM 12-INCH GUN.
Penetration, 4½ inches and 6½ inches.

thick. The projectiles each weighed 850 lbs. The first shot resulted in a penetration of the plate to a depth of 4½ inches, the shell being wrecked and the plate stalled; the velocity in this case was 1,616 foot-seconds and the energy 15,407 foot-tons. With the second and third shots, there was a penetration of 6½ inches with the same effect on the shells and plate, the velocity being 1,691 foot-seconds and 1,723 foot-seconds respectively, while the energy was 16,870 foot-tons and 17,514 foot-tons respectively.

The armor-plates of some of the largest battelships and cruisers in the world have been constructed at the plant of the Bethlehem Steel Company, as well as some of the largest guns with which these war vessels of different nations have been equipped.



NICKEL-STEEL OIL-TEMPERED BALLISTIC ARMOR-PLATE.
Pierced by three Shots from 8-Inch Gun.



Inventions

The Problem of Getting a Patent—The Requisite Steps—Pitfalls to be Avoided—Qualifications of the Solicitor

Second Paper

By EVERETT E. KENT

Counselor-at-Law and Patent Attorney

MINERVA, deity and good genius of the Greeks, stepped forth from the brain of Jove, mature and fully armed at birth. Modern brains work with less facility. The record thus established by Jove is rarely equaled to-day. The usual history of a commercially successful invention is a record of experiments and partial successes, involving adjustment and readjustment and new devices before the idea is complete and the machine in condition to work smoothly and compete effectively in the market.

This means expenditure of time, money, and labor by the inventor. Conversely, it furnishes to a host of other thoughtful minds—to every one who learns it, in fact—opportunity to invent and patent improvements upon the original device. A broad-minded owner of the original invention will always give respectful consideration to such improvements with a view to their purchase. Many a business may thus be made secure, though based on a main patent which is weak and tottering; and so, likewise, a monopoly may be extended after the expiration of the main patent. This happens when the control of the subsidiary invention, no matter how small it may be, enables its owner to present to purchasers a more attractive proposition than competitors who are free to sell or use only the original device are able to offer. Notable instances of this are the telephone monopoly and the two great electrical machinery companies, whose fundamental patents have already expired, but who continue, nevertheless, to dominate the market.

A Wise Precaution

Before much expenditure, it is well to learn what progress others have already made in the art to which the invention relates. This is most conveniently done by an examination at Washington of the records of patents previously granted, supplemented, perhaps, by a glance into a suitable mechanical dictionary or textbook. A cursory search costing but a few dollars enables the inventor to judge whether it is worth while to continue his experiments and to go to the expense of an application for patent. The best way is to send to a patent attorney a simple sketch and description of the invention sufficient to convey the idea, stating what is thought to be novel. This is cheaper and more effective than for the inventor to attempt the search himself. The Patent Office will not make such a search except in connection with an actual application for patent. The annual indexes of patents, which can be found in public libraries throughout the country, are not classified with sufficient analytical exactness to be used with satisfactory results for this purpose.

The preliminary search may show that a crude form of the device has already been conceived by another. The inventor must then consider whether his improvement is a sufficient advance to amount to a patentable invention; and whether such a patent, being narrower than first expected, would be worth its cost. The

fact that the earlier patent may still be in force and may contain claims dominating his idea, will not prevent the grant of a patent to him upon his specific improvement; but he will not thereby acquire any right or license to use the subject-matter of the earlier patent. Each patent stands on its own merits, and remains unaffected by subsequent patents. The improvement may be useful enough to justify hope of an amicable arrangement with the earlier patentee, either by purchase or sale, or by exchange of licenses, so that both patents will be worked together.

In cases of doubt, especially where the validity of an issued patent is questioned, a more exhaustive search to show the state of the art can be made at an expense running from $20 to $100 or more, according to the time consumed by the expert in making the search.

The Formal Application

A formal application for a patent in the United States consists of a *specification, claims, oath,* and *petition;* also a *drawing* where the nature of the case admits of it. A model is but rarely required. With a certain grim humor, however, the Patent Office invariably requires a working model when the invention is a perpetual motion machine. The government filing fee is $15. The specification must describe the invention clearly, and the manner of making and using it; also, if it be a machine, it must explain its principle, and the best mode in which the inventor has contemplated applying that principle. It is a fraud on the public, and the patent may be declared invalid, if the inventor withholds the best mode he knows.

The person who signs the application has to make oath that he believes himself to be the original and first inventor of the improvement; and that he does not know, and does not believe, that the same was ever known or used before his invention or discovery thereof. This provision of law prevents the issue of a valid patent on the application of any person who first learned of the invention from another, whether honestly — in a friendly way, or by agreement or purchase—or dishonestly, by theft.

The original inventor may sell or assign the invention, and his rights to a patent thereon. Sometimes an invention is made in the course of a man's employment, as a part of the duties for which he receives a salary. In such cases the invention is sold in advance. If the inventor refuses to execute proper application papers and an assignment to his employer, he may be compelled to do so by an order of court. The mere fact, however, that a man is an employee, does not entitle his employer to the patent, if the making of the invention be outside the scope of his duties.

Choosing a Solicitor

The most important single feature connected with procuring the patent, is the selection of the solicitor who is to manage the application. Upon his ability and integrity, more than on anything else, depend the scope and value of the patent. The art of soliciting patents is highly technical. There are men of all grades of ability in this profession, as in others; and unfortunately there are some quacks —men who could be called impostors but for the fact that their names are in truth officially registered as attorneys. Inasmuch as inventors and men of genius are notably poor business men, a word of warning here can do no harm. Just as every business concern which advertises to sell something for nothing proves to be a fraud, so a person who offers to solicit patents at rates less than ordinary, and sometimes to give a bonus in addition, will generally give services that are in some way worth correspondingly less. Do not let your judgment be warped by a lean pocketbook. Some kinds of "economy" come high. If the invention is valuable, if you hope to sell it for one thousand or one hundred thousand dollars or more, the difference of a few dollars paid to employ a competent solicitor may make the difference of hundreds or thousands of dollars in the selling price. It is not impossible that it may make the difference between a patent that is salable and one that cannot be sold at any price. The unfortunate thing is that no inventor, unless he be himself an expert, is able to judge how well his case is being handled—not even on receiving and examining the patent. The quality of it does not appear until

long after, when a business has been built upon it, and when the patent is tested in the fierce light of litigation. Therefore a good solicitor, in addition to having the necessary breadth of technical knowledge, must also be a competent lawyer, of experience in patent litigation, and familiar with the way courts interpret patents and alleged anticipating devices.

Least of all should the inventor attempt to prosecute his own application. It is worse than going into an apothecary's shop to mix his own drugs, for there he can at least avoid the bottles labeled "Poison;" but in the Patent Office nothing is labeled, and there is no knowing how he may damage his case.

People think of the Patent Office as the great assistant of inventors; and so it is, in a sense. By means of it, fortunes are made. The enormous industrial advance of the United States in the present and past century, is due largely to its beneficent influence. But in another sense the Patent Office is not the inventor's friend. Its examiners stand equally to protect the great non-inventing public who desire to use freely all fruits of inventive genius. To the hopeful applicant they seem more like obstructionists than promoters. They are fluent with reasons why his claims should be narrowed or abandoned. They drop never a hint how the claims might be broadened. If the claims presented lie *within* the area of advance made by the invention, they will be allowed; *all the rest* of that advance —including, perhaps, parallel ways to attain the same end—they quietly permit to go unclaimed and thus be dedicated to the public. The inventor suffers no wrong in this. If he does not ask for all he might, that is not the Government's fault. It does, however, emphasize the need of having a good solicitor.

The extent of professional services that will be required to get proper patent protection, cannot be told accurately in advance. It depends upon what obstacles are raised by the Patent Office; and the action of the Office can never be foretold, unless, indeed, the claims are made deliberately narrow.

The Solicitor's Task

Proceedings in an application are conducted in writing. Letters from the Examiner and from the applicant or his attorney are entered alternately in the file of the case; and the action of the Patent Office is based upon the written record. Ordinarily there is no occasion for the inventor to visit Washington; and he cannot facilitate the progress of his case in the least by so doing. It is believed that the Patent Office is entirely free from "influence" by Senators or Congressmen or other public officials.

In almost every application, one or more claims are allowed early in the proceedings, the others being rejected on references cited by the examiners from the prior art. By canceling or narrowly limiting the rejected claims, the applicant can then have a patent—such as it is—issued at once. But let the inventor beware. Land in New Mexico and land in New York would both be conveyed by " a deed;" but one might be worth a dollar an acre, and the other a dollar an inch. The fallacy of the "No patent, no pay" bid for business, thus becomes manifest. What the inventor really wants is not merely "a patent"—with his name at the top, and a blue ribbon, and an official red seal. Narrow claims are easy to get—and are usually not worth the cost of getting. A patent with claims too narrow is like a boat having one or more planks missing. Every plank in the boat serves admirably to keep water out at its particular place; but at the places where there is no plank at all, water comes through freely, and the boat is useless.

Claims broad enough to make the patent valuable have usually to be fought for, and sometimes demand the highest skill of the solicitor's art, both to perceive wherein the inventor's advance over the prior art really consists, and to frame and prosecute successfully claims covering that scope fully. The Examiners are not to be treated as infallible. The law provides for appeals to the Board of Examiners-in-Chief, to the Commissioner of Patents in person, and to the Courts. The official rejections of claims are not always based on reasons that are legally sufficient. The test of ability comes in determining what is the utmost that the applicant is legally entitled to have allowed out of the rejected matter; and in then presenting the rejected claims to the

Examiner anew—revised, if necessary—with such arguments as will command his assent. In such cases a clear vision and a courageous attack are needed, coupled, perhaps, with a skillful modification of the application.

If conflicting applications are filed by different inventors for a patent on the same invention, the Patent Office institutes "interference proceedings," which are conducted as in court to determine by means of evidence who was the first inventor.

Foreign Patents

When the application is finally allowed, it will be issued on payment of a final government fee of $20 at any time within six months. Meanwhile the papers remain secret, and the inventor can avail himself of this delay to apply for patents in foreign countries. He may file his foreign applications earlier if he prefers—but not more than twelve months before filing the United States application, under penalty of having the latter refused. In most foreign countries, such application has to be made before the invention is described in print in any country. In some, it is sufficient to apply before a printed description reaches the country. In some countries the patent will be granted only to the inventor or his assignee; in others, to the first applicant. In England the saying facetiously is that "the man with the fastest cab-horse wins."

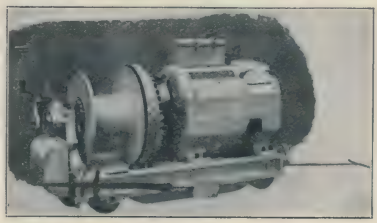
Coaling at Sea

Modern Appliances that Avoid the Dangers and Delays of Older Methods

By P. C. FERGUSON

THE present war between Russia and Japan, and in particular the sailing of the Baltic fleet for the scene of hostilities in the Orient, not only show the importance of having numerous coaling stations, which must be strongly fortified and garrisoned and made self-defending, but also indicate the necessity of having ample means for coaling at sea when great distances must be traversed and when neutral harbors are not open for coaling purposes.

Many plans have been proposed for coaling ships at sea, a large part of which are considered unsafe by prominent engineers. During a heavy sea it is generally considered unsafe to employ broadside coaling; and the "end-on" system of cableway plant is usually employed.



ELECTRIC WINCH ON RUSSIAN BATTLESHIP "RETVIZAN" FOR OPERATING MARINE CABLEWAYS WHEN COALING AT SEA.

In order that this system may be safe, experienced engineers maintain that a good distance must be provided between the battleship and the collier, 400 feet being considered a minimum by conservative experts, while no connecting line should be made fast to both ships, except the tow-line, so that, in the event of the tow-line parting, the lines of the cableway would clear themselves.

RUSSIAN BATTLESHIP *RETVIZAN* TAKING COAL AT SEA FROM A COLLIER.

A marine cableway permits a fighting vessel to stay in the fighting line, and allows a fleet of war vessels to arrive off the enemy's coast with bunkers full instead of being displenished. No navy can have too much coal, or too many ways of obtaining it, in time of war.

One of the most important improvements in coaling ships under the marine cableway system, has been in the method of delivering the coal after it reaches the deck of the vessel. Until recently, as on the U. S. S. *Massachusetts*, a pair of shears were erected and guyed, supporting a large canvas chute, through which the bags of coal were dropped. This has now been dispensed with in some instances; and the ropes of the cableway are pulled down by means of a "nigger-head" on the quarter-deck winch at the time it is desired to dump the load.

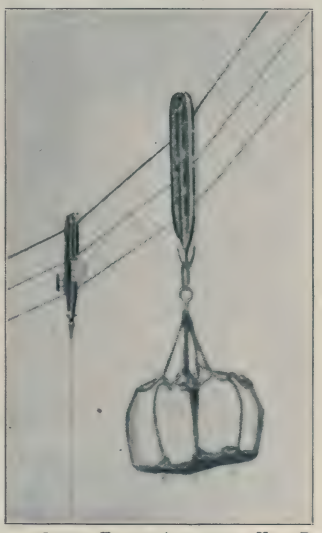
In harbor coaling, nigger-heads are used, and they will hoist 2,240 lbs. at the rate of 300 feet per minute. The slipping drum will develop a rope speed of about 1,700 feet per minute, and will lift a load of half a ton. These winches operate the load carriage between the collier and the warship, one winch carrying the loaded carriage toward the warship, the other drawing the empty carriage back to the collier. For this purpose, a single wire rope, about 2,000 feet in length and ⅜ inch in diameter, is employed. In many cases both winches are operated by electric motors, and run all the time in the same direction, the ropes being always taut. The friction of one slipping drum overpowering the other gives the reciprocating motion to the load carriage. The rope is being wound up on the drum of one winch, while it is being paid out by the other drum under

Coal Elevating Trucks Loading Bags on Deck of Collier Ready for Hoisting to Masthead.

tension through the slipping of the friction head, the heat developed by the slipping being dissipated by air passages and radiating fins. It is stated that this method of operating a load carriage is independent of the relative motion of the two ships, since, when the ships pull apart, one drum slips, thus paying out rope, while the slack given to the rope is wound in when the ships approach each other. It is essential, however, that the rope speed of these winches be greater than the speed at which the ships approach each other. .

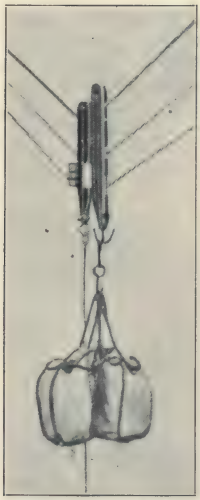
It may be of interest to note some details of the electrical equipment of one of the Russian battleships for taking a supply of coal while at sea.

The ill-fated battleship *Retvizan*, disabled by the Japanese at Port Arthur, was equipped with the Lidgerwood-Miller marine cableway, which is an American system of coaling at sea. This system is operated by two electric winches, the slipping drum being mounted on the armature shaft of the electric motor. The drum has a diameter of 14 inches, and gives a rope speed varying from 1,200 feet per minute at full load to 2,000 feet per minute at half load. The first warship to be completely equipped with the marine cableway, was the U. S. S. *Illinois*. Its equipment will permit that battleship to take coal at sea from any masted vessel that it may meet in any quarter of the globe. The British collier *Muriel*, on several sea trials, delivered from 35 to 40 tons of coal per hour in a moderate sea and half a gale of wind



Load of Coal in Transit Approaching Haul-Down Block on Warship.
A load is being lowered at the same time.

"Retvizan" Coaling at Sea, Collier in the Distance.
View from After-Deck of Battleship.

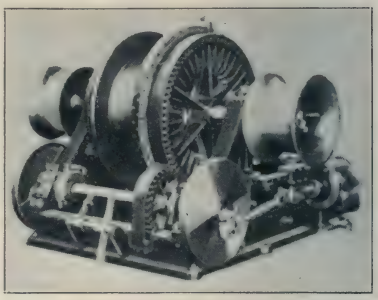


COAL LOAD CARRIAGE IN CONTACT WITH HAULING-DOWN BLOCK A FEW INCHES ABOVE DECK OF BATTLESHIP.

to H. M. S. *Trafalgar*. The battleship towed the collier at speeds varying from eight to eleven knots an hour. The same collier also coaled H. M. S. *Empress of India* at sea at the same rate; and at one of the English trials, Vice-Admiral Sir G. H. Niel had his fleet of seventeen ships witness the operation for the benefit of the officers on board. The accompanying illustrations show the method of coaling the Russian battleship *Retvizan* at sea from a collier which it is towing.

By having warships equipped in this way, it is claimed that the question of coal supply is largely solved, since vessels can coal directly from any collier and are not dependent upon coaling stations. Any masted ship, either sailing vessel or steamship, can do duty as a collier, and deliver its coal at sea to any warship equipped with a marine cableway. Even a destroyer could be coaled at sea by a collier, when properly equipped. Capt. E. M. Shepard, U. S. N., Light-House Inspector at Tompkinsville, N. Y., has stated that "out of 365 days ending November 30, 1900, the log book of the Sandy Hook light-vessel shows that the sea was smooth 121 days, moderate 196 days, rough 47 days, and very rough one day." It is claimed that coaling at sea could have been accomplished 317 days out of the 365 off Sandy Hook.

The load starts out from the collier on a down-hill route, continuing so for more than half the distance. When the load is just clear of the center of the span and in its lowest position, the man on the quarter-deck of the warship commences to pull down the block. By the time the bags reach the haul-down block, they will be trailing on the deck. The operator will stop for an instant, the lowering will continue for a foot or more, the load will be unhooked from the carriage, the empty bags put on, and the whole allowed to rise to its normal position. At the same time, the operator on the after-bridge will send the empty carriage back to the collier for another load by means of the electric winch above referred to.



STEAM DOUBLE-CYLINDER WINCH ON U. S. S. "ILLINOIS." 8¼ x 8 in. cylinder; 30 in. diameter drum.

BOULDER BRIDGE.
The most pleasing construction in Rock Creek Park, Washington, D. C.

New Bridges Around Washington

Some of the Enduring and Artistic Engineering Constructions Supplementing Nature's Handiwork at Beauty Spots in the Vicinity of the National Capital

By GUY ELLIOTT MITCHELL
Secretary, National Irrigation Association

DURING the last ten years, Congress has been fairly liberal in its appropriations for the improvement of the outlying districts of the national capital, and the Army engineers have taken much pride in devising plans for enduring and artistic engineering work.

Rock Creek Park

Rock Creek, a small stream which for years was the dividing line between Washington and Georgetown, is a watercourse possessing great natural wild beauty in the seven or eight miles from its debouchure into the Potomac back to where it is a placid stream traversing farm and meadow lands. Considerable of a torrent in the flood season, it has cut its way through the comparatively high outlying hills and heights north and west of Washington. Appropriations aggregating some million and a-half dollars were made by Congress to purchase 2,000 acres including the Creek, for the establishment of a national zoölogical garden, and, adjoining it on the north, a national park, known as Rock Creek Park. While the primal beauty of this region has, perhaps, not been enhanced by the building of perfect driveways and many bridle paths and the construction of handsome bridges, these works have made it possible for the country lover to visit and see this section. heretofore the haunt only of a great variety of birds and wood and water animals.

The earlier history of the District of Columbia bird and animal life shows Rock Creek to have been an exceptional breeding place. Over 500 species of birds have been observed within ten miles of the national Capitol building, and 100 have been known to breed within this

limit. Many of these have retired from the scene since the opening of the Park; but in the early mornings of spring, Rock Creek is still alive with dozens of species of feathered songsters.

The Extension of Washington

The City of Washington itself is rapidly encroaching upon the Park; and while the conservatives vigorously opposed such a large government expenditure in securing this land, the wisdom of Congress is now apparent. Magnificent residence structures now overlook the Park from the city side, while beyond, land which a few years ago was undivided farms, is now being built up with handsome suburban residences, and the trolley takes people quickly back and forth from the city. One of the most important improvements is the extension of Massachusetts Avenue. This is a government project nearing completion, and costing about $200,000. The Creek flows through a capacious granite tunnel with a 50-foot span covered by a huge embankment 80 feet high, which rises to the grade of the Avenue, enabling it to cross the Rock Creek ravine.

Another large bridge project for which the pier foundations are going down, is the extension of Connecticut Avenue northwest, the cost of which will be about three quarters of a million dollars. This imposing masonry bridge will be from one of the best designs of the late George S. Morison, assisted by Edward P. Casey, whose work in bridge architecture has attracted considerable notice. The bridge will have five full-center spans of 150 feet each, and two full-center end spans of 82 feet each. The piers of the large arches are 20 feet thick; and those between the large and small arches, 37 feet. These thicknesses were determined partly on the ground of satisfactory construction,

STYLISH LITTLE CEMENT AND PEBBLE BRIDGE.
Crossing a tributary of Rock Creek in Rock Creek Park, Washington, D. C. Cost, $4,200.

for the scheme of work contemplates the simultaneous construction of the large arches and the consecutive building of the short arches. The bridge will be 52 feet in width between the faces; and the total length between abutments, 1,341 feet—a quarter of a mile. Above the main arches are a number of full-center spandrel arches having spans of 14 feet each, and supported by transverse spandrel walls 3 feet thick. These arches are open over the 150-foot spans, but closed by face walls at the piers and over the 82-foot arches. The main arches are to be built of 1:2:4½ Portland cement concrete; the transverse walls, spandrel arches, and most other parts, of 1:2½:6 Portland cement concrete. Alternative

proposals will be received for cut-stone and for moulded concrete blocks for parts of the trim and faces.

Rustic Ornamentation

One of the handsomest rustic ornaments of the Park is a steel, rock, and cement bridge faced with rough, natural boulders, each as large as the body of a big man. This structure justly has the name of being one of the most artistic examples of engineering construction in the country. It has an 80-foot span and a 15-foot rise, and carries a 23-foot roadway. The clear width between the parapets is 23 feet; width over all, 27 feet. This locality of Rock Creek made it desirable to build a boulder bridge, if possible, for æsthetic reasons; but, as only $17,500 was available for construction, it was necessary to adopt some less expensive type, that selected being a Melan concrete-steel arch with a boulder facing, the concrete of the soffit being artificially darkened to harmonize with the faces of the stones. The specifications state that the boulder face of each stone shall project at least two inches beyond the neat lines of the bridge and not more than fifteen inches. The mortar consists of one part Portland cement and two parts sand. Two men were employed to do the entire boulder work, which, while apparently natural, required considerable dressing on the interior faces. Each stone is attached to the top of the adjacent steel girder by a solid steel cramp cemented for at least two inches in a hole in the stone. The outside girders were bound together, just before the concrete was put about them, by means of four ¾-inch wire ropes. A number of arch stones were made by splitting boulders in two pieces. The bridge was designed under Captain L. H. Beach, Engineer Commissioner of the District of Columbia. The contract was for $14,890, exclusive of steel and royalties, which made the total cost $17,500, the amount of the appropriation.

ROCK CREEK TUNNEL UNDER MASSACHUSETTS AVENUE.
Culvert, 50 feet clear span, 200 feet long; rise, 32.5 feet.

Any Sunday, thousands of stylish equipages cross this small span, their occupants enjoying the wild surrounding scenery, which but a few years ago was the resort of the small boy, willing to tramp miles to enjoy a cool swim in a deep, secluded hole.

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¶ Build to stay.

¶ Opposition cures apathy.

¶ Man judges by our hits, God by our aims.

¶ He has made no great gains who has never lost anything.

¶ A good many trains of thought are unable to get off the side-track.

¶ No man's a failure till he's dead or loses his courage, and that's the same thing.

¶ Watching the other man's patch will not keep the weeds out of your own.

¶ Far and away the best prize that life offers is the chance to work hard at work worth doing.

¶ All really great work is rough in the doing, though it seems smooth enough to those who look back upon it, or to contemporaries who overlook it from afar.

¶ You cannot go forward without leaving some things behind.

¶ Everything should have some use, and we have no use for the thing that hasn't.

¶ Of course there are always some men who are not affected by good times.

¶ Above all, let us remember that our success in accomplishing anything depends very much upon our not trying to accomplish everything.

Wanted—A Waterfall!

NOT so long ago a waterfall was nothing more than a picturesque feature of the landscape. Its chief purpose was to inspire the rhapsodies of poets, and to furnish artists with subjects for spectacular paintings. But now comes the science of engineering, and makes a waterfall a valuable commercial asset. All over the world, trained engineers are out looking for waterfalls as prospectors used to look for gold mines. And, if a fall be found within fifty miles of a large city—or even farther off—it is likely to pay a larger profit than the richest of Golcondas. For a waterfall is a source of power, and power is a commodity for which the demand is limitless.

Few mechanical inventions have produced more spectacular results than those which, by means of the electrical transmission of power, have made available the energy generated by far-off torrents of water. Already it has come to pass that a mountain river, tumbling over a ledge of rocks in some remote, almost inaccessible fastness, has been harnessed to turbine wheels, and forced to furnish light and power to the inhabitants of a city fifty miles away on the seacoast.

For months Russian engineers have been searching the country about St. Petersburg for a waterfall which might do the work of the Czar's metropolis. Now they have found it. Up in rocky New England, the mountain rivers and brooks are being made allies of the manufacturing interests of that section.

Even in Chicago, located as it is on swampy ground on the shore of Lake Michigan, the building of the great Drainage Canal to the Mississippi has made possible the creation of an immense water-power plant which may well, in the not remote future, furnish light for all the streets of the metropolis, and leave, besides, a surplus to be applied possibly to the running of municipal street-railways.

The possibilities of solar motors and tide motors are as yet undeveloped. Meanwhile there is still plenty of wasted water power, which waits only the hand of the skilled engineer to be turned into a source of permanent profit.

Don't waste your time looking for a gold mine! Go out and get an option on an undeveloped waterfall!

Electricity on the Farm

THE use of electricity on the farm offers inducements of which American farmers seem to be ignorant, but which would transform farm life into an existence of convenience and luxury from one of toil and frequent discomfort. France and Germany seem to realize the advantage of electricity on the farm, and the American agriculturist could gain many valuable ideas by touring the rural districts of those countries. Not only is this force capable of making the farmer's life more enjoyable, but it can be made a source of wonderful economy of labor and consequently a source of wealth. The cost is insignificant compared to the advantages. The American farmer, however, plods along in his easy way, taking it for granted that electricity is only for the convenience of the city. On the contrary, electricity can be made of tenfold more advantage to the farmer than to the urban resident: and he can better afford to enjoy its blessings, because the cost to him would be comparatively insignificant. He can have his own electric plant, whereas the urban resident must depend on the electric monopoly in the city where he dwells, and pay several times over the value for every electric light or other convenience electric power may afford. Frequently the farmer is so situated that the cost of an electric plant would be a minimum. Perhaps there is a waterfall nearby; or, if not, there is probably a swift-flowing stream somewhere on his land, which could readily be made to operate a plant to supply all the electricity needed. Or the necessary water force might be obtained by building a dam in any kind of running stream, and employing a simple water wheel such as can now be purchased at very low cost. Or, again, electric energy can be generated from a windmill and stored away in a storage battery. In fact the windmill offers a magnificent prospect as a source of electrical energy. Some farmers have not been slow to realize this, but most of them have concluded that the windmill can serve no other purpose than to pump water. One farmer near Chicago has everything about his place operated by electricity through the agency of a couple of big windmills. By means of electricity the house and grounds are lighted, and water is pumped for the cattle; electric bells are on all the doors; electric signals connect all the buildings; there is an electric burglar alarm system; a local telephone system reaches to every room in every house; his wife's sewing machine is run by electricity; her laundry iron is heated by the same means; and they have a small electric stove which is used when the power is not required for other duties.

But even this enterprising farmer has not applied electricity to perform the most important farm work, as is done in France and Germany. In these countries, motors are adapted for doing all kinds of work—plowing, cultivating, reaping, etc. On smaller farms, tenants combine, making one motor do the work for all by carrying it from place to place as needs require. The saving of labor is so obvious, that, even among the most conservative, the value of the motor is admitted. By burying electrodes in the earth, and then applying electric power, the ground is freed from everything in the nature of crawling and creeping things, solving the problem of dealing with pestiferous insects.

A writer says:

"Even the farmer need only touch a button if he will avail himself of the results of modern science."

Automobiles on Railways

THE automobile hasn't altogether chased the horse off the highway, though many horses have left the highway abruptly on the sudden appearance of the automobile. Fortunately this phase of the matter has practically passed. Horses have horse sense; and where their drivers have the same, the first surprise and distrust have given way to fraternal sympathy. The horse and the auto have common aspirations after all. They both want good roads, so that they may jog along together in peace and comfort. So the horse remains on the highway, where the automobile is also pervasive and prevalent.

Lately, however, the automobile's pervasiveness has passed the limits of the macadam, and the touring car of the day is whizzing down the shining rails that span the continent. This is a genuine surprise. We have been told that in time the electric locomotive would take the place of steam in local traffic; but to have the gasoline auto exploding itself along the rails that have hitherto resounded only to the thunder of the mighty drivers of the great moguls, seems the limit of audacity. Yet to the audacity of modern invention there is no limit, and already the rail automobile is an accepted factor in modern transportation. When, last September, Chas. J. Glidden, renowned as an auto-tourist, made his record run of 1,800 miles on steel rails from Minneapolis to Vancouver, in 60 hours—averaging 30 miles an hour through the mountains—we were all delighted, but surprised that such things could be. Yet—so rapidly does the world move—the same scheme was being worked out in half a dozen places. Already automobile manufacturers are busy supplying specially constructed cars to the railroads, and one American maker alone has built and delivered more than a hundred such cars. They are used for inspection cars for division officials, for switching purposes, and even for passenger service on one line at least, a spur track out in Utah. For switching, the gasoline automobile is said to show superiority in economy and convenience over the switching locomotive; it costs less in the first place, works for less, is always ready, and one man is both fireman and engineer.

This is a rather new phase of automobiling to us; yet in Italy, France, and Austria, gasoline automobiles are in use in regular railway service; while in England, steam motor coaches on the unit basis have been in regular use since 1903. The automobile's progress is quite wonderful. If it hasn't driven the horse from the highway, it has made him divide its use; and it seems to be in a fair way to do the same thing with the steam locomotives on the big railroads.

Agencies Supplanting Coal

AS a matter of fact, various agencies threaten to supplant coal as a source of light, heat, and power, though in most instances it is still merely a threat. Petroleum is one of these. The scent of it mingles with that of the orchids in the tropics, and the polar bear sniffs it as he climbs the floes. The world over, it is doing its work—noisily and noisomely, but steadily and well. In some places it only supplements coal, in others it supplants it, but in both cases its use is steadily extending. But the thing that really bids fair to down the coal baron in the happy future is not petroleum—it is the electrical transmission of water power. To paraphrase Bunthorne, "Coal and coal oil may fade and perish, but water power is practically undying because it may be renewed whenever it exhibits symptoms of decay." There is enough water running down hill in the United States to supply all the heat, light, and power that the country is likely to need for generations to come. Modern technical science is now busy putting this water to work; and though but the spray of the whole vast cataract of power has been touched, the results are astonishing. Just a little of the water of Niagara has been diverted for power purposes, and only a fraction of this goes to Buffalo; yet Buffalo, in a single month, saves 14,000 tons of coal through this electrically transmitted water power. In Montreal they save about 8,000 tons of

coal a month in the same way, and Montreal has not begun to utilize the edges of her nearby cataracts. San Francisco uses electrically transmitted water power, to the saving of 100,000 tons of coal a year. These are the largest instances on this continent, but there are a thousand smaller ones. We have already learned well how to capture this energy of the waterfalls. Day by day we learn better how to transmit it. When we shall have learned how to store it against future needs, as we surely shall, we shall be able to flout the coal baron and smile pityingly upon the Standard Oil, for light, heat, and power will be obtainable in unfailing supply as long as rain falls and water runs down hill.

Where Were the Airships?

THE loss on the St. Louis Exposition will be $100,000 less than it might have been. That was the sum offered as a prize for a successful airship. Before the Fair opened, this promised to be a great feature. Airships of many various shapes and dimensions were depicted in the illustrated papers and magazines, many in minute detail; and all these, we were assured, would make the heavens populous during the time of the contests. That they did not do so, is probably no fault of the Exposition management; but the fact remains that they didn't. Professor Langley's *Buzzard* was not entered, perhaps because it dived rather than flew on every trial. Berliner, also of Washington, did not enter his aëroplane. Professor Bell, inventor of the telephone, whose tetrahedral kites have been heralded the world over as the one form of aëroplane which will make flight possible, was not on hand with any flying machine made up of tetrahedral cells, as we had hoped for. Holland, inventor of the submarine boat; Sir Hiram Maxim, of gun fame; the Lebaudys; August Greth; Octave Chanute; and a host of others—ninety in all—were reported as having entered for this amazing contest. Not three of all that throng dared face failure on the arena. At any rate, they were not there. Santos Dumont came, and went away with his gas bag punctured—how nobody knows—but he did not fly, nor try to. And so the story goes. The only machine which seems to have even approached the conditions called for in the contest was that of Baldwin, whose *Arrow*, a dirigible balloon, sailed about above the grounds in calm weather and even made headway against a slight breeze. It is doubtful if even this craft could be considered enough of a success to be called an airship, and it certainly does not seem to have been deemed worthy of any prize. The airship invention seems to be in the main still "in the air;" and though there is no doubt that it will in time be successfully worked out, the St. Louis prizes, big though they were, failed to bring forth any evidence of it.

Counting Coin Electrically

VERY few of us have any trouble in counting our coin by hand. In mints, however, in banking houses, in the offices of electric railways, and in many other establishments, vast quantities of coin have to be counted and packed daily. An electrical machine lately devised counts coins of any size from pennies to dollars, and wraps them at the rate of 420 per minute as long as the current is transmitted and the coins are fed into the hopper. An expert, while he is in good working order, can count and wrap fifty coins a minute; so it will be seen that the machine does the work of eight men. It takes a man to run the machine, however, his work consisting of sorting the coins, picking out plugged pieces, blanks, and buttons, which in some cases seem to get mixed with good money. The machine receives the sorted coins at one end, and delivers them all smoothly rolled in bunches to suit and with the wrapper pasted. It is the invention of a man whose business it was to collect coins from slot machines and to sort, count, and bundle them. His explanation of the reason that such a machine was never invented before, is that hitherto inventors have never had any money to count.

First Naval Training Station on the Great Lakes

Government School for Seamen to be Established on Lake Michigan—Picturesque Site Selected at Lake Bluff, Illinois, a Northern Suburb of Chicago

By RUTLEDGE RUTHERFORD

RECRUITING sailors from the Middle West is a new venture to be systematically undertaken by the United States Government. Of course, sailors have long been recruited from this section of the country, and are officially recognized as ranking among the finest in the service; but heretofore the Western youth who wanted to enter the Navy, usually had to go to the seacoast to volunteer his services. Now, however, the Navy has decided to go hunting after the Western youth, and the conditions are about to be reversed. The Government has decided to establish a naval training station on Lake Michigan, in Illinois. It will be located at Lake Bluff, a northern suburb of Chicago, on one of the most picturesque sites that could have been found in America. The novelty of a government naval training station on the Great Lakes has created a world of newspaper comment in Chicago; and Lake Michigan is beginning to feel wonderfully important since it is to be made to harbor real war vessels and become the field of training real tars to share in the defense of American interests at home and abroad.

The selection of the site at Lake Bluff was made by a naval board appointed for the purpose, and approved by the President. The board recommended this site in its final report, November 11, 1903; but Congress suggested other locations on the Great Lakes as probably more advisable because of the high price asked for Lake Bluff land. Accordingly, a number of Chicago's business men, after joint deliberation, secured options on the land, and offered it to the Government freely, in return for locating the station there. This removed the last objection,

SHORE OF LAKE MICHIGAN AT LAKE BLUFF.
View near site of projected naval training station.

LAKE MICHIGAN IN ONE OF ITS VARIABLE MOODS.
An approaching storm as viewed from site of new naval training station at Lake Bluff.

and the decision in favor of Lake Bluff was unanimous.

The Secretary of the Navy already has in hand $250,000 with which to begin preliminary work in transforming the grounds into training quarters. Other appropriations will be made from time to time as required, for buildings and harbor improvements. Buildings to accommodate from 2,000 to 3,000 young men will be erected, and suitable training vessels will be put in service.

The school is for the training of boys from 15 to 17 years of age enlisted as naval apprentices. They agree, on entering the school, to serve in the Navy until they are 21 years old. The course contemplates six months' schooling at the station, after which the boys will go to a training ship, and, on reaching the grade of first-class apprentice, will go to a naval vessel in commission. The school will be different from other educational or training schools, in that those entering it are to be clothed, fed, and lodged at the expense of the Government, and are to receive, in addition, $9 per month until they reach the grade of first-class apprentice, when they will receive $21 per month. Only boys of good character will be accepted, and the discipline will be more rigid than that of the ordinary training school.

The Government already has naval training stations at Newport in the East, and San Francisco on the Pacific coast.

WINTER SCENE AT LAKE BLUFF.

Chicago is practically midway between these points, and hence meets the desirable condition of being equidistant from all probable sources of recruiting supply.

Dampness in Houses

Its Prevention and Cure

By RUFUS E. MARSDEN
English Expert in House Sanitation

ONE of the most vital requirements of a dwelling-house is that it shall be dry. To be dry it must be so constructed that it will resist all attempts of a variable climate to make it damp. The destruction of pictures, carpets, and furniture is only a small item of the ill effects that generally accompany the occupation of a damp dwelling; for injury to furniture can never be regarded so seriously as injury to health, and the premature shortening of life. Pneumonia, rheumatic fever, neuralgia, and phthisis are a few of the more dreaded diseases to the development of which a damp environment seems favorable; and, in addition, there is always present a greater liability to the common "cold," with its possibilities of leading to more serious complaints.

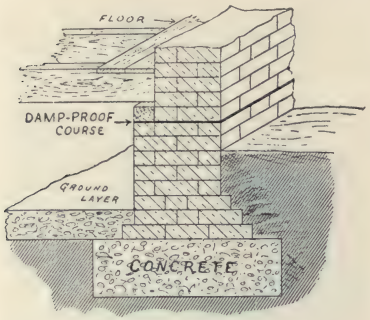


FIG. 1. WALL WITH DAMP-PROOF COURSE.

This being so, it is of general interest to know the methods by which we can prevent the entrance of this most insidious enemy—damp—into our houses.

All possible methods fall into two great classes: those of prevention and cure. And while prevention is ever the best and safest course, yet a cure is always to be regarded as a blessing.

An eminent professor told his audience that they ought to thank the jerry-builder for making houses into which fresh air could always gain an entrance, no matter how much the inmates tried to exclude it by the use of draught preventers. But when suggesting that our thanks were due to the jerry-builder, the professor forgot to mention that we could not feel thankful for the intrusion of damp.

Apart from bad design, bad work and inferior materials are responsible for dampness. Like the modern besieger, damp attacks our castles from above, below, and sideways. If the roof has a weak place, our enemy finds it; if our walls are not what they should be, he knows it before we do; and if the upward path, from the soil on which the house stands, be not obstructed — well, that way in is as good as any.

To prevent the damp from taking possession of our walls, by entering through the brickwork in contact with the ground, a damp-proof course must be inserted at a level of from three to six inches above ground line (Fig. 1). This damp-proof course may consist of sheet lead, asphalt, sheet bitumen, a double course of slates in cement, or stoneware slabs specially made for the purpose. In the majority of houses the damp-proof course is only a few inches above ground line, as it is necessary to place it beneath the level of

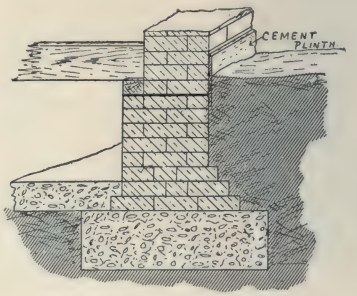


FIG. 2. WALL WITH CEMENT PLINTH.

the ground floor, as in Fig. 1. I was recently consulted in a case where a previously dry house became damp, and it was thought that perhaps the excessive rains in the early part of the year had been the sole cause; but on inspection I found that the surrounding ground had been made up for garden purposes, so that the level of the earth was above the damp-proof course, and this had led to the mischief. An economical and yet satisfactory method of remedying this state of affairs, where it exists, is to dig the earth away from the walls of the house, and run a Portland cement plinth along the wall, extending from a few inches above ground level, to a short distance below the horizontal damp-proof course, as in Fig. 2.

In very wet subsoil the horizontal damp-proof course alone is not sufficient to keep the damp out of the dwelling. Especially is this true when the lowest floor is below the outside ground level.

The best method of constructing a house in a damp situation is by building an open area, as shown in Fig. 3, all around the dwelling. Another method is to build the wall in two portions, with a cavity between, as shown in Fig. 4. This cavity should be drained and ventilated, but at the best it is not so good from many points of view as the open

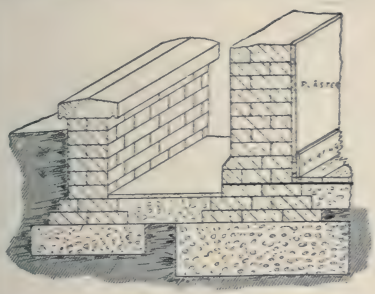


Fig. 3. Dry Area.

area. An economical way of keeping the wall dry is to render that surface of it which is in contact with the ground, with Portland cement or asphalt, the latter being preferable; or the cavity between the two walls in Fig. 4 can be made about one inch wide, and filled in with some damp-proof material, such as White's hygeian rock, or asphalt.

A regulation properly imposed in London is, that the sites of all buildings shall be covered with six inches of good concrete. This has been shown in diagrams, Figs. 1-4, and it constitutes another bar-

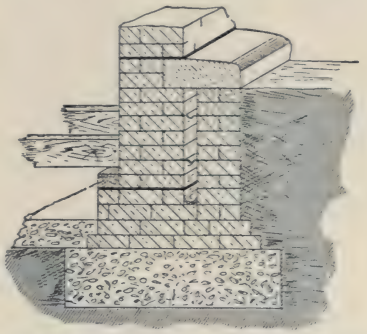


Fig. 4. Floor below Ground Level with Cavity Wall.

rier to the entrance of damp. But as concrete alone is not impervious, it is necessary, in very damp situations, to finish the top surface with either neat Portland cement or asphalt. Wherever it can be applied, asphalt renders a wall impenetrable to moisture. Callender's sheet bitumen can be used with like effect.

To prevent damp from entering through the walls of a house, it is necessary that they be constructed of thoroughly sound materials; porous bricks and weak mortar readily absorb any moisture they come in contact with. The joints of the brickwork should receive attention, the best form of joint being that shown in Fig. 5, and known as a "struck" or "weathered" joint. Another form of the same joint not infrequently met with in practice is shown in Fig. 6. This is obviously a bad method of forming the joint, as the small ledge at the bottom of the joint forms a resting-place for rain, instead of rapidly conducting the water off the joint.

A form of joint very popular with a certain class of builders, is given in Fig. 7, and is known as "tuck pointing."

This is usually adopted when the quality of the work requires disguising, because the whole surface is either rubbed over with a piece of soft brick of good

color, or a colored wash is smeared over it; then a small white band of lime putty is stuck on to the center of the hidden joint. This small band has the appearance of a neat white joint, and imitates one indication of good work. The white band is much better inserted as in Fig. 7, but this is not always done; and even when it is, the joint is not anything like so durable as the weathered joint. The only time when tuck pointing can be recommended, is when the bricks have crumbled away at their edges, leaving very ragged joints. To make a lasting job, pointing should be done by raking out the joints to the depth of three-quarters of an inch, and then filling in with good cement mortar, finished with a weathered joint.

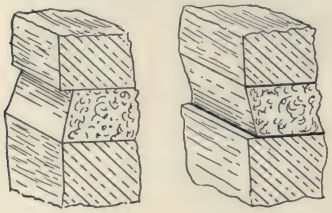


FIG. 5. Correct Form. FIG. 6. Incorrect Form. WEATHERED JOINT.

In very exposed situations, where driving rains are prevalent, hollow walls are built. As shown in Fig. 8, these consist of two walls, with a cavity between them, the two walls being tied together with stoneware or iron ties. The thin wall faces the weather, and the cavity prevents the inner wall from getting damp. In walls so constructed, care must be taken to prevent door and window frames from getting damp through moisture running down on the inside of the outer wall. This can be accomplished by the provision of a small lead gutter, as in Fig. 9, placed above the arches over the openings.

In cavity walls, the cavity helps to preserve a more equable temperature in the interior of a house, besides preventing dampness.

To prevent walls built in one piece from becoming damp, after the house has been built some time, several methods may be adopted. A preparation known as "Fluate" has proved to be a real preservative, and makes the surface to which it is applied damp-proof. The liquid can be directly applied to stonework, while for brickwork it is necessary only to use a dressing of "Avant Fluate," and then a dressing of "Fluate of Magnesia." There are patent silicate paints on the market for the same use;

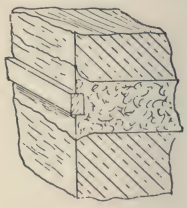


FIG. 7. TUCK POINTING.

but two coats of Portland cement wash will form an effective cure of damp walls.

Other remedies are:—the application of three coats of boiled linseed oil; paraffin paint, prepared by dissolving one part of paraffin in two to three parts of coal-tar oil, at a moderate heat, oil being mixed with it to prevent it from quite congealing when cool; and hanging tiles, or a rendering of Portland cement stucco. The tiles used should be well burnt, so that the exposed surfaces are

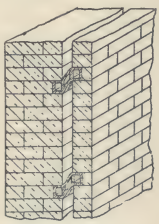


FIG. 8. PORTION OF HOLLOW WALL.

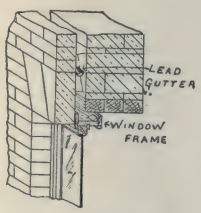


FIG. 9. HOLLOW WALL OVER WINDOW-FRAME.

impervious to moisture; they can either be fixed by nailing direct to the brickwork, or battens may first be nailed on, as shown in Fig. 10. Slates may be used instead of tiles. To keep the face of the wall as free from wet as possible, all window sills should stand out beyond the face of the wall, and have a small groove, known as a "throating," run along their projecting under surface, as

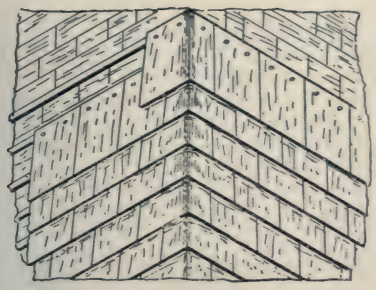


Fig. 10. Tile-Covered Wall.

in Fig. 11. Cornices and string courses should project and be throated in a similar way; and the joints in rain-water pipes should be secure. Only quite recently I saw an example of a damp wall caused by a small zinc rain-water pipe, which had been broken off a short distance from the ground, discharging against the brickwork and above the damp-proof course. The remedy was simply the mending of the rain-water pipe, so that it discharged away from the wall.

The slates and tiles on roofs should be of good quality, and so laid that the rain is quickly conducted into the gutters, which must be kept clean. It should be borne in mind that a straight roof can be more easily made and kept water-tight than can a roof cut up into numerous surfaces and angles. As regards the windows, the ordinary "guillotine" sash that slides up and down in two pieces

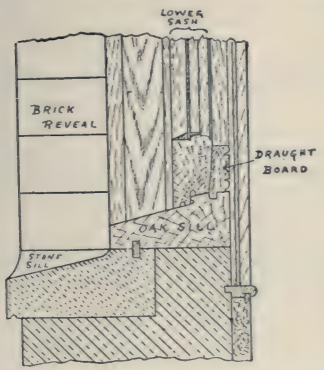


Fig. 11. Bottom Part of Best Form of Sash.

is most easily made water-tight. In Fig. 11 the bottom part of the best form of such a sash is shown; a window board has been fixed to the lower end of the frame, so as to permit the lower sash to be opened for ventilation purposes without causing a draught. When the

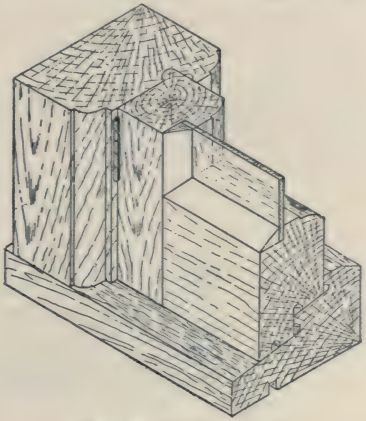


Fig. 12. Waterproof Casement.

lower sash is raised nearly to the top of the window board, fresh air is admitted between the two sashes, thus giving ven-

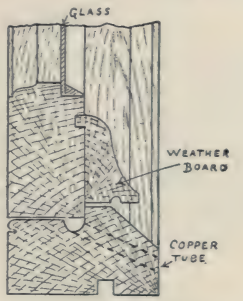


Fig. 13. Casement Opening Inwards.

tilation, even in windy weather, without draught.

For pleasantness the ordinary guillotine sash does not compare with the casement sash in fine weather; and when the casement is made to open outwards, it can be rendered water-tight in the manner shown in Fig. 12.

For convenience of cleaning, it is desirable that casements should open inwards, and other circumstances sometimes demand it; but casements so opening are less likely to be water-tight. In Fig. 13 one of the methods by which this joint is made most satisfactorily is shown; the hollow groove in the sill should have a small copper pipe connected with it so that water getting into this groove may find its way out.

The joints between the bottoms of doors and the door sills may admit the rain in exposed situations. To remedy this, a weather board can be fixed onto the lower part of the door, so that any water running down the face of the door is conducted away from the joint between door and sill.

A metal water bar can be inserted in the sill, when the latter happens to be of wood, and the bottom edge of the door rebated to fit over it.

A little attention to details such as those mentioned will do much to make a house comfortable. In conclusion it must be pointed out that all gutters and water pipes should be periodically attended to, so that they may be kept quite free from obstruction.

Dinner-Pail Philosophy

¶ No man is happy if he does not work.

¶ Don't discourage yourself by starting with "I can't."

¶ The more successful a man becomes, the more careful he should be and keep his head level.

¶ In the long run the most disagreeable truth is a safer companion than the most pleasant falsehood.

¶ Many a man who imagines he could run the earth can't even manage a small garden successfully.

¶ You can buy a lot of home happiness with a mighty small salary, but fashionable happiness always costs just a little more than you're making.

¶ Daylight is a powerful discourager of evil.

¶ Shutting the eyes to the danger signal does not clear the track.

¶ "Don't hurt anyone if you can help it; but if you must, a clean, quick wound heals soonest."

¶ We can as little afford to tolerate a dishonest man in the public service as a coward in the army.

¶ The man who is not a tender and considerate husband, a loving and wise father, is not serving the Lord when he goes to church.

¶ Every man who has made wealth or used it in developing great legitimate business enterprise, has been of benefit and not harm to the country at large.

The "Foolkiller" and Its Victim

Peder Nissen, Conqueror of Niagara's Whirlpool, Succumbs to the Mystic Power of Lake Michigan

By PAUL ARR

Staff Correspondent, THE TECHNICAL WORLD

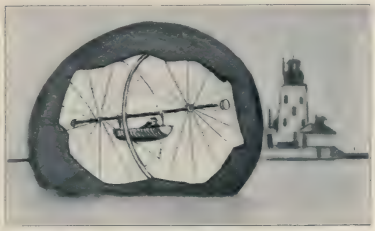
"FOOLKILLER NO. 3" was so named by its inventor, Peder Nissen, a Dane. It was the oddest craft that ever floated on any water; and it proved the tomb of Nissen in what is probably the most daring adventure of the century.

The *Foolkiller* was a huge air-inflated rubber and canvas ball, which Nissen believed could be made to carry a passenger and to roll across water or land in any kind of weather. He had visions of inclosing himself in the bag and letting the wind roll him to the North pole. Nissen proposed to demonstrate the practicability of the contrivance by having the wind in a 30-knot gale roll it across Lake Michigan, from Chicago to the Michigan shore, 65 miles. He figured that the trip could be made in five hours. He did not deem it advisable to test the machine by letting it roll across the lake by itself; and he had too much consideration for the lower animals to place a dog or a guinea pig in the aquatic balloon to see if such a creature could endure the voyage. Instead, he decided to lock himself in the air-bag; and the test was to demonstrate that if he lived the *Foolkiller* was a success, but if he died it was a failure. It proved a failure—that is, so far as regarded the conditions of the test.

Nissen was used to daring adventures, many declare, just for the sake of the notoriety they afforded. Twice he had shot the Niagara whirlpool rapids, being the only man in the world to perform the feat. In 1900, under the name of Captain Bowser, he went through in an open boat, and again in the same year in a barrel-like craft with center cockpit and heavy metal keel.

Nissen had heard of the treacherous waters of Lake Michigan, which has been termed the "Lake Baikal" of America. He had read of boats that had mysteriously sunk in this lake and never been heard of again; of the unknown fate of the steamer *Chicora*, which dared Lake Michigan in a storm, with the result that not a soul on board, nor a fragment of the vessel, was ever afterward seen; of aëronauts who were lost in attempting to cross the lake in balloons; of skaters who were never seen again after starting on proposed ice-journeys from Chicago to St. Joe; and of the popular superstition that Lake Michigan punishes with death any mocker of her mysterious powers. So, to Nissen, the conditions seemed ideal, under which to demonstrate his daring.

The *Foolkiller* was made of rubber, covered with canvas 3-32 inch thick and



NISSEN IN THE "FOOLKILLER" PASSING THE LIGHTHOUSE. Showing cradle suspended from central shaft; also cords which served as ribs.

treated with three coatings of linseed oil. The craft was 30 feet long, and 22 feet in diameter. From one end to the other extended a steel pole three inches in diameter, in the ends of which were fitted sticks of oak, like the spokes of a wagon wheel. From the ends also extended scores of small ropes fastened to the inner

surface of the balloon, to hold it intact; and there were numerous supports of steel ribs. From the center of the steel pole, a wooden, trough-shaped cradle was suspended; and just over this, also suspended from the central shaft, was a square wooden chair, so arranged that the navigator could either sit in the chair or lie in the cradle as he desired. The chair and cradle, or wooden hammock, hung loosely from the revolving shaft, so that they would always remain upright and below the shaft, except in the event that the balloon should turn over endwise, which Nissen thought would be impossible.

The *Foolkiller* was built exceedingly strong. It was water-tight and air-tight, except when air was pumped in through a one-inch rubber hose fastened to a part of the balloon near the axis of the center shaft, which the designer figured would always be out of the water. He had arranged to tie the tube with a string to prevent water from being washed into the balloon by the waves. The air-pump was a hand-power machine about the size of a foot-power bicycle pump. Both ends of the air-bag were provided with small glass windows resembling portholes, one of which could be opened to admit the navigator. A small oil lamp was Nissen's only source of warmth inside the rolling ball.

Tuesday, November 29th, a gale was blowing off shore, and the weather was bitter cold, when Nissen crawled into the air-bag at 3:30 P. M., and asked the curious crowd to close the porthole after him. Although he expected to reach the opposite shore in five hours, he took along, as provision for emergencies, three days' rations, consisting of crackers, candy, and chewing gum. The air-bag went bounding over the waves. The first big gush of wind it encountered in the open lake turned it on end; but it quickly righted itself; and the crowd, including relatives and friends, watched the strange craft until it was a mere speck on the horizon.

Thursday, December 1—just 36 hours after the start—Nissen's dead body was found in the surf near Stevensville, Mich.; and, 200 yards away, was the air-bag, a shapeless mass of twisted steel ribs, broken timbers, and torn canvas, washed ashore and covered with ice. Nissen's clothing was frozen to his body. In the wrecked air-bag was found a note which read as follows:

"NOTE No. 1.—My air-hose is broken. I am doomed to die of suffocation.—PEDER NISSEN."

A coroner's jury found that Nissen died of "exposure and shock." They believed that he reached the shore alive, but terribly exhausted from lack of air; and that, after cutting his way out of the bag, he died of neuro-paralysis the moment he struck the cold. Nissen was 43 years old and unmarried.

Faith

BETTER trust all, and be deceived,
And weep that trust and that deceiving,
Than doubt one heart, that, if believed,
Had blessed one's life with true believing.

Oh, in this mocking world, too fast
The doubting fiend o'ertakes our youth!
Better be cheated to the last,
Than lose the blessed hope of truth.

New System of Voltage-Control

A Type of Controller Giving Variable Speed from Ordinary Shunt-Wound Motors Operated on Constant-Potential Systems of Any Voltage

By H. C. TROW, S. B.

Instructor in Electrical Engineering, American School of Correspondence

THE new voltage-control system described herewith has recently been put on the market, and exhibits many features of interest. Fig. 1 shows a photograph of a 3-horse-power controller with vertical motor and interrupter; while Fig. 2 shows a wiring diagram of the same. The manufacturers claim that while this system is simple, it allows very minute changes of speed; and since this is accomplished with the ordinary two-wire system of distribution, complications in the wiring are thereby eliminated.

The operation of the system is based upon some of the well-known laws of alternating currents applied to an interrupted constant-potential service, constituting a voltage-control pure and simple. The regulation is secured by the act of varying the periodicity of interruptions, coupled with an adjustment of the relative period of make and break.

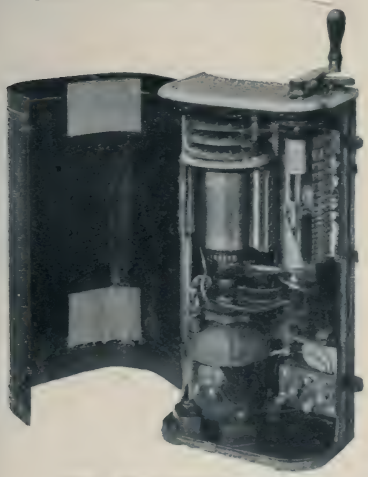


FIG. 1. NEW TYPE OF CONTROLLER.

The controller comprises within itself all the features found in a number of separate devices usually employed in connection with motors, and is complete within itself. One part includes a complete starting-box for the motor; another part has for its object an automatic handling of the motor circuits under ab-

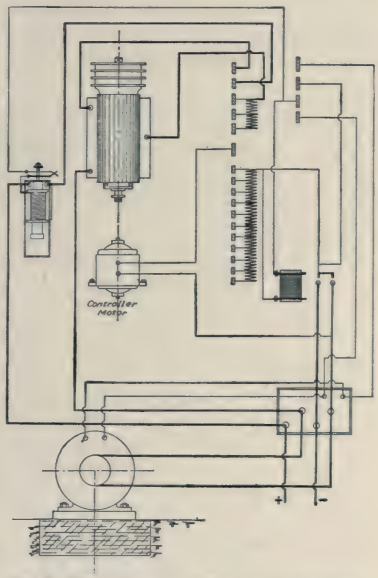


FIG. 2. WIRING DIAGRAM OF VOLTAGE CONTROLLER.

normal conditions. For instance, there is a complete release system which opens the main switch in case of the power being temporarily cut off. Again, there exists an overload cut-out which operates in accordance with the latest practice in that the device is timed and will not operate under instantaneous and incidental rises of current which generally exist,

but will effectually open the circuit, and save the apparatus, as soon as the overload shows a tendency to persist unduly. Besides this, the controller contains means for automatically connecting and disconnecting its own operating motor, allowing this motor to remain in the circuit only during such portions of the total motor control as are necessitated by the function it fills; also special shunting means for the interrupter, and, with some forms of motor, for changing the periodicity as well as the relative interval of open- and closed-circuit relation. Moreover the controller is under automatic control in case of rupture of the local circuits, independently of the overload cut-out mentioned.

The slate terminal block shown in the lower left-hand corner has six terminal points—two to the main line, two to the field, and two to the armature of the motor controller. The pulsations or periods of make and break are secured through the variously sized segment commutator which is revolved by the small motor at the bottom. The contact cylinder at the top is simply a device for making the contacts, similar to that found in any ordinary controller. The sliding contact which is shown at the left side of the commutator, takes in various segments on the commutator by means of clips inserted in the segments, this being accomplished by moving the handle of the controller proper. This action changes the period of make and break, thus also changing the voltage impressed on the motor armature only. The controller also has an overload release: and, as the voltage impressed on the field undergoes no change, the torque also is maintained constant throughout the entire operation.

Chanty

By M. B. R.

THE Lord, He made His mighty host to gather up the seas,
He spread His everlasting nets to save the shrimping souls,
He lifted up the deadly sick from out the dregs and lees,
And He kept the Wayward Sailor from the shoals—
Oh, He kept the Wayward Sailor,
With a forehand to his eye,
Lest the kelp and keel together sing a sobbing lullaby,
When a mist is in the weather,
And a murk is in the sky—
For the Lord, He loves the helpless Wayward Sailor.

The mighty notes of Heaven sound from out the booming gale;
The thresh of seas, the sting of rain, the sweeping of the blast,
Commingle song eternal into one almighty "Hail!
Ye have kept the Wayward Sailor to the last;
Ye have kept the Wayward Sailor
With his tarry hands and numb,
Ye have kept him from his silent Death—Lord, keep him from his rum!
He keeps the trackless sea-wastes
When the world is grey and dumb;
O Lord, protect the helpless Wayward Sailor!"

Mercerization of Cotton

How to Obtain the Silky Luster so Much Desired for Certain Commercial Purposes*

By E. B. WAITE
Instructor in Mechanical Engineering, American School of Correspondence

THE action of strong caustic soda (or caustic potash solution) on cotton is not only remarkable, but the practical application of this action has proved of great interest and value to the textile industry.

If a piece of cotton cloth is steeped for a few minutes in a solution of caustic soda (50° to 60°, † Tw. Sp. Gr. 1.25 to 1.30), it assumes a gelatinous appearance; and when taken out and washed, it is found to have shrunk considerably in surface area, and become of much closer texture. Should a single fiber of this cloth be examined under the microscope, it will be found to have lost the appearance of a perfectly normal cotton fiber. The spirally twisted appearance has disappeared, and it has no superficial markings, but has become thick, straight, rod-shaped, and transparent. The sectional appearance has also been entirely changed. It has no longer the appearance of a flattened tube, but is cylindrical, while its walls have thickened until the central opening has become a mere point. Cotton treated in this way not only is increased in strength, but has a greater attraction for coloring matters.

This peculiar action of caustic soda was discovered by John Mercer, a Lancashire calico printer, more than fifty years ago, while attempting to filter a concentrated caustic soda solution through a piece of cotton cloth. Later he patented a process for treating cotton cloth with caustic soda; hence the term "mercerization."

*NOTE—The mercerizing process can be applied only to cotton; and therefore many of the so-called "mercerized" articles, such as "mercerized worsteds," are misnamed. Though the process has proved of value for other purposes, its principal use at the present time, and undoubtedly the most important application of the process ever made, is in the production of a silk-like gloss on cotton yarn by treating it in such a way that it cannot shrink.

†NOTE—To find the specific gravity or density of liquids, hydrometers are used. There are various forms, such as Baumé, Twaddle, etc. The Twaddle (abbreviated to Tw.) is used for liquids denser than water.

Mercer's Original Process

Mercer's process consisted in simply passing the cloth through a caustic soda solution, when the action already mentioned took place. The results were that cloth counting 200 threads to the inch would become so compact as to count 270. The increase in strength for a given width was 50 per cent, or even more, and a given amount of cloth would increase in weight 4.5 to 5.5 per cent. The fabric also assumed a finer superficial appearance, and an increased luster and affinity for dyestuffs.

At one time it was thought that an application of this process to cotton cloth would be of great value to the textile industry, as will be seen by the fact that Mercer was offered $200,000 for his patent in 1852, which he refused to accept. The cloth, however, shrank from 20 to 25 per cent in length as well as in width; and this, together with the fact that its increase in durability would tend to make the call for fresh supplies less frequent, led to its abandonment.

It is still an open question, in this country at least, as to the legal claimant to the process of producing luster on yarn by mercerization. The most aggressive claimants are Horace Arthur Lowe, who took out certain patents about 1891, and Thomas and Prevost, who took out others in 1895.

General Principles

The various processes for obtaining this silky luster differ mechanically in the method of preventing the shrinkage; but the general principles involved are the same in all, and are as follows:

The mercerizing bath consists of a caustic soda solution kept commonly at a specific gravity (Sp. Gr.) between 50° and 60° Tw. Solutions of a Sp. Gr. less than 15° Tw. have but slight mercerizing action. For the best results the temperature should remain low, about 15° C. and not over 20° C.

The time of immersion is of little conse-

quence, so long as the yarn is thoroughly saturated. Ten minutes is usually long enough. The yarn is commonly under tension when it enters the mercerizing bath, but in some methods it is subjected to tension upon being taken from the bath. In either case, however, it is necessary that the lye be washed from the yarn before tension is relieved.

Although all cotton receives a silky luster upon mercerization under tension, up to the present time it is only long-staple cotton, such as Egyptian and Sea Island, that appears to receive enough luster to make its mercerization practical for this purpose. The gassing of the yarn before it is mercerized also seems to add materially to the luster of the finished product. Gassing consists in rapidly passing the yarn through a gas flame for the purpose of singeing the projecting superficial fibers.

Commercial Applications

At least two other applications of mercerization have proved of importance:

First, the production of seersucker effects by printing on a cotton cloth a narrow stripe of strong caustic soda paste. The cloth shrinks where the caustic soda comes in contact, and when washed and finished, a seersucker effect results.

Second, the production of two-color designs by printing a figure on cotton cloth with a caustic soda paste, and then dyeing in a bath containing a direct cotton color. If the color be a blue, the result will be a light blue ground and a darker blue figure; and similarly with other colors. This effect is due to the increased affinity for dyestuffs of that portion of the cotton fabric that has been acted upon by caustic soda.

Other reagents, such as strong sulphuric acid and a concentrated solution of zinc chloride, if properly used, produce an effect similar to caustic soda, but they have never been introduced on a practical scale.

As to the chemistry of mercerization, the accepted theory at the present time is similar to that advanced by Mercer—namely, that the change is due to the formation of a hydrate of cellulose.

Chromatic Projection Apparatus

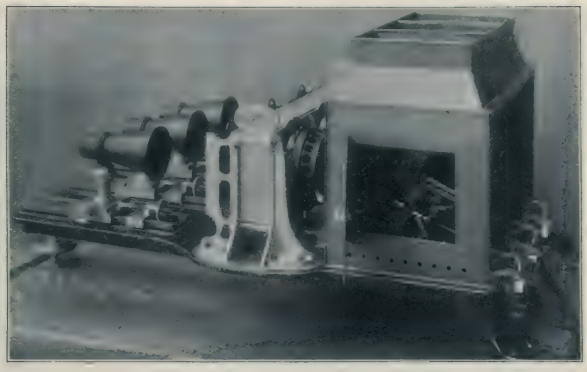
An Ingenious Device for Throwing Views upon a Screen in all the Colors of Nature

By DR. ALFRED GRADENWITZ

Berlin Correspondent of THE TECHNICAL WORLD

THE accompanying figure represents a large color projection apparatus constructed by the firm of C. P. Goerz, of Berlin and New York, which was exhibited at the World's Fair. The apparatus is intended for projecting on a screen three monochromatic views as obtained by the Miethe color photography, in such a way as to produce by their combination the impression of natural colors.

The underlying principle of the color photography just referred to, consists in obtaining three partial views of the object, through color filters corresponding respectively to the three fundamental colors—red, yellow, and blue. In the place of these, Professor Miethe prefers using red, green, and blue, which is quite feasible, as green is a combination of blue and yellow and thus contains both of these fundamental colors. As these partial views correspond to the green, blue, and red portions of the object respectively, into which all the different shades of the latter may be decomposed, it suffices to superpose them with their proper colors, to produce a natural impression.



CHROMATIC PROJECTION APPARATUS.
For throwing naturally colored views upon a screen.

To this end, the partial views are printed as diapositives on glass plates; and these diapositives are projected on a screen, interposing in the path of the light rays a light filter (colored glass or the like) strictly identical with those used in photographing.

The projection apparatus used for this purpose allows of a ready adjustment of the partial views on the same spot of the screen. It includes three electrical arc lamps, receiving their current from the same switchboard, which enables the current intensity to be varied between 10 and 35 amperes. The condensing lenses used to obtain the projections are a triple-lens system of three components each, through which the rays from the lamps pass on their way to the diapositives and the projection objectives, while being given a convenient convergence. In order to utilize as far as possible the luminous power of the lamps, the aperture ratio of the condensing system is as great as possible, while a cooling vessel cuts off any heat rays which might endanger the diapositives.

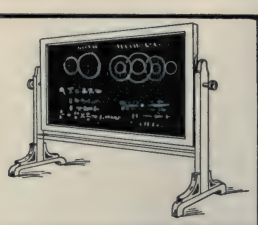
On the figure will be seen three optical benches, fitted on the foundation plate of the apparatus, and on which the projection objectives are made to slide. All three of these objectives, which were constructed specially for the purpose, are provided with a coarse and a fine displacement in the direction of the optical axis, in order to allow of ready adjustment; while special horizontal and vertical movements of the lateral objectives are provided for, in order to adjust the apparatus for every projection distance. The foot-screws serve for adjusting to the center of the projection screen.

The most important feature, however, is the device for adjusting the partial views. Into an aluminium frame are cut three rectangular apertures at convenient distances apart, to receive the diapositives, which can be fitted tightly by means of clamps and screws. Instead of carrying out the adjustment in the projection apparatus itself, a special adjusting device is used. This is similar to a dividing machine, on the carriage of which have been arranged two displaceable microscopes that are free to rotate so that the point of intersection of their cross-wires can be made to coincide with any desired point of the central partial view. After next transmitting these points to the two other partial views, the diapositives are screwed fast in the adjustment frame.

Professor Miethe uses color filters consisting of two glass plates, between which the colored layer has been interposed. An interlocking device has been provided, so that the filters are exposed to the intensive radiation of the lamp, only during the time they are actually used.

The intensity of the projections obtained with this apparatus is such that a faithful likeness to nature is secured, the more so as the size of the projection is sufficiently great and the colors are extremely bright.

CHALK TALKS



by CARL S. DOW.

Number Eleven—The Cooling Tower

The Condensing Engine

IN the last Chalk Talk (Number Ten, p. 488), it was pointed out that by cooling the exhaust from a steam engine, the power developed by the engine is increased in the neighborhood of 20 per cent. This discussion referred to gain in *power* only, and cannot be taken to mean *financial* gain. Under some conditions the gain in dollars and cents may equal this gain in power. For instance, if the plant is near a natural water supply which gives an abundance of cold water, the financial gain will be considerable. But if, on the other hand, the cooling water must be purchased at city rates, there is little if any economy in condensing; in fact, it is sometimes cheaper to run non-condensing.

Amount of Cooling Water Required

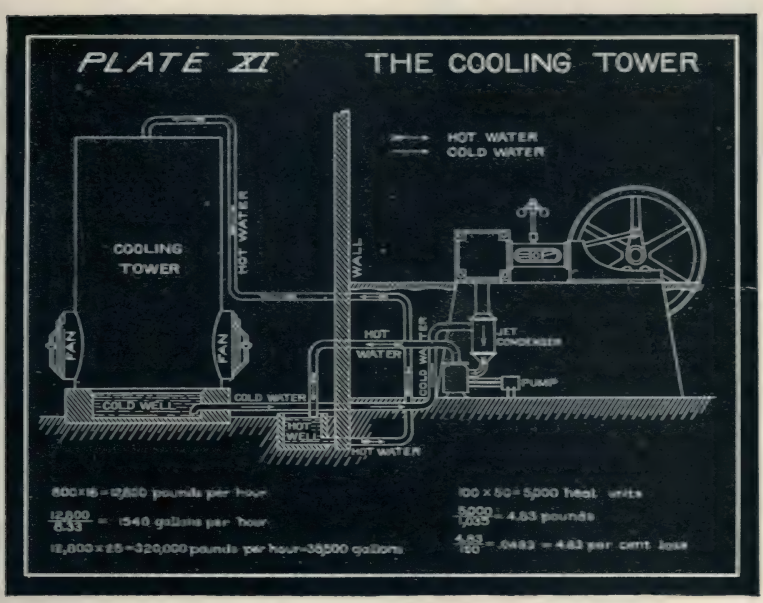
One not familiar with steam engineering has but little idea of the amount of water necessary to cool the exhaust steam. Let us take as an example an 800-horse-power engine. An engine of this size is built for economy, and uses from 14 to 18 pounds of steam per horse-power per hour. Taking the average value, the engine would use 16 × 800 (= 12,800) pounds of steam per hour. This is equal to about 1,540 gallons. The amount of water necessary to cool this steam varies considerably, depending upon the temperature and the vacuum to be carried.

Let us take an average value, and assume that conditions are such as to require 25 times as much cooling water as steam. Then the 800-horse-power engine will require 12,800 × 25 (= 320,000) pounds per hour, or 38,500 gallons. For a day of ten hours, 3,200,000 pounds —or 1,600 tons—will be necessary. Even at moderate cost per thousand gallons, the total water bill for the year would be considerable.

The Cooling Tower

One can readily see that it is desirable to do away with this great expense, and yet take advantage of the benefits resulting from the use of a condenser. The most natural way to accomplish this, is to cool the water after it has absorbed the heat of the exhaust steam, and use it over and over again. The best method yet devised is the Cooling Tower, of which there are several types.

The principle is very simple:—The cold water enters the condenser, and, in cooling the steam, becomes warmer. This warm water flows to the hot well (see blackboard), from which it is taken and pumped to the top of the tower. Here it flows over extended surfaces, trickling over slats, mats of wire cloth, or trays, to the bottom, where it collects in a reservoir, called the "cold well." The circulating pump draws it from this well, and forces it again to the condenser. While trickling over the cooling surfaces, the water comes in contact with the air



which rises in the tower either by natural draft or a fan.

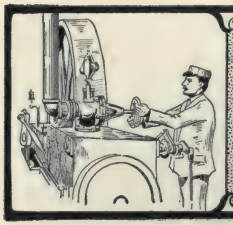
Cooling of the Water

The cooling effect is due to three causes:—Radiation from the pipes and sides of the tower, contact with the cooler air, and evaporation. The last is the most important. In Chalk Talk Number Nine (p. 314), the process of mechanical cooling due to evaporation was explained; in this case, however, instead of liquid ammonia, some of the cooling water evaporates, and in so doing absorbs a sufficient amount of heat to lower the temperature of all the water through 40 to 50 degrees.

From the definition of the heat unit, we know that to cool 100 pounds of water 50 degrees requires 100 × 50 (= 5,000) heat units. An investigation of the properties of steam shows that about 1,035 heat units are absorbed when 1 pound of water at 110 degrees is changed into vapor at 110 degrees. Therefore, to reduce the temperature of 100 pounds of water 50 degrees, the amount of water which must be vaporized will be:

$$\frac{5,000}{1,035} = 4.83 \text{ pounds.}$$

In other words, 4.83 pounds of water is evaporated for every 100 pounds of water cooled 50 degrees in the tower. This will be reduced somewhat by some heat being lost through radiation and through contact with the air. Thus we see that by the evaporation of from 3 to 5 per cent, the water is cooled sufficiently to be used again. As no water is lost except that due to evaporation, but little water need be added to make the process continuous.



ENGINEERING PROGRESS

Enormous River Dredge

WHAT is claimed to be the largest suction river dredge anywhere in operation, was recently constructed at Portland, Oregon. This colossal dredge is at work on the lower Willamette and Columbia rivers, deepening the ship channel between the cities of Portland and Astoria. It has been appropriately christened *Columbia*.

The dimensions of the dredge are: Length over all, 226 feet; beam, 42 feet; draught, 6 feet. It is of the hydraulic type, the distinguishing feature being a rotary excavator at the end of a pipe through which a stream of water is forced by a very powerful centrifugal pump.

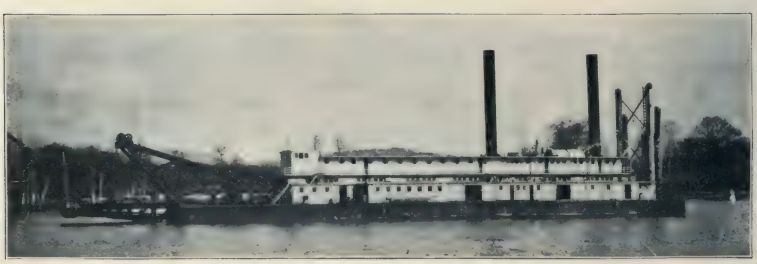
The excavated material is broken up by the excavator or cutter, thoroughly mixed with water, and passed through the pipe to the dumping ground. The suction and discharge pipes are 40 inches in diameter. On the lower deck are the immense engines of 1,000 indicated horse-power which drive the great pump winches, the excavator, and the dynamo and conveyor. The boilers are on the same deck. The cost of the *Columbia* was nearly $270,000.

The chief purpose of this great machine is to secure a permanent ship channel from Portland to the sea, of a minimum depth of 40 feet at the mouth of the Columbia river, and 25 feet at the shallowest stages between Portland and Astoria.

It might be added, that, by order of the War Department, the big United States transport *General Grant* was recently converted into a sea dredge, and has been at work off the mouth of the Columbia river, deepening the ocean approaches. Without doubt the *General Grant* is the largest sea dredge in the world.

Trolley Dining Cars

A TROLLEY DINING CAR is an innovation recently established by the Aurora, Elgin & Chicago Railway Company. At present the cars are available only to special parties; but next season they will be placed in general service, making four runs daily between Chicago and the Aurora and Elgin terminals.



LARGEST RIVER DREDGE IN THE WORLD.

The *Columbia*, operating on the lower Columbia and Willamette rivers, near Portland, Oregon.

TROLLEY DINING CAR.
Aurora, Elgin & Chicago Railway.

Theater parties returning to suburban homes after an evening's entertainment in the city, will find the cars especially adapted to their needs, as will the golfers who patronize the suburban links.

The dining cars were built at a cost of $12,000 each. The one shown in the illustration, the first to be installed, is named the *Carolyn*. Twenty-eight persons can be accommodated in the comfortable wicker chairs at its tables. The length of the car is 55 feet, six of which are taken up by the kitchen. The service is inclined to be of the light buffet order. The car is equipped with a motor, and can be sent out alone if necessary.

Cable to Alaska

ALASKA is brought nearer to the rest of the United States by the new cable from Sitka to Seattle, which was completed Sunday, August 28. There is now an all-American line of telegraphic communication between Sitka and every other important point in the United States. The cable is 970 miles long, and was sent from the Atlantic coast to Seattle around Cape Horn. The next step in the development of telegraphic communication with Alaska, will doubtless be the stretching of a cable 539 miles long from Sitka to Valdes on Prince William Sound, in accordance with recent recommendations of the Secretary of War. This would place the completed system of telegraph lines in Alaska in direct communication, by way of an all-American line, with the telegraph systems of the whole world.

The cable from Sitka to Seattle was laid under Act of Congress of March 2, 1903, and was to extend from Sitka north to Juneau, and south to Seattle. The cable connecting Juneau and Sitka, 293 miles long, was laid in 1903.

A telegraph system of 1,740 miles—1,486 on land, and 254 cable—was given

INTERIOR OF TROLLEY DINING CAR.

to Alaska under Act of Congress of May 26, 1900. This system connects Fort St. Michael, on the south shore of Norton Sound, with Fort Davis and Nome City, on the north shore; and, running easterly from St. Michael to the valley of the Yukon, passes up that valley to Fort Gibbon and Rampart. From Fort Gibbon it passes up the Tanana and Good Pasture to Fort Egbert and Eagle City, and thence southerly across the divide through the Copper river country to Valdes. A separate cable, 120 miles long, connects Skagway, at the head of Lynn Canal, with Juneau. Thus there is cable communication between Seattle, Skagway, and Juneau; and in northwestern Alaska there is a complete cable system connecting all important points with Valdes, on the southern coast. There is, however, no connection between Valdes and Sitka.

Though the Alaskan cable system is very important as it stands, its value would be quadrupled by the construction of a line to Valdes. Not only would it be of importance with Alaska itself in mind, but also with the growing commerce following the line of the northern route to the Orient. Soon ports on the Aleutian islands, and on the southern coast of Alaska, will become enriched from this new commerce and will grow rapidly in population and wealth. Somewhere on the southern Alaskan coast a great commercial city is bound to arise. This will result from the development of the interior of Alaska, as well as through our increasing Pacific commerce. Essential to this development is a thorough telegraph and cable system enabling all Alaska to talk with all the world.

A Colossal Windmill

WHAT is undoubtedly the largest windmill in the United States, if not in the world, has very recently been constructed near San Francisco, Cal. It is located on the ocean beach, not far from the famous "Seal Rocks," and quite near the beautiful Golden Gate Park. Its purpose is to augment the water supply required for the irrigation and cultivation of this immense public garden of about 2,000 acres. On an average, the mill pumps 350,000 gallons of water every 24 hours. Of course, ocean water is not pumped, as this would damage or entirely destroy flowers, grass, and shrubs; but a great well has been sunk,

COLOSSAL WINDMILL NEAR GOLDEN GATE PARK, SAN FRANCISCO, CAL.

which furnishes an unfailing supply of fresh water. After being pumped up, the water is driven through a 14-inch main nearly two miles long, to a large reservoir located near the center of the Park, from which it is distributed through pipes.

The round, wooden tower is about 120 feet high, and nearly 50 feet in diameter at the base, gradually tapering upward. Near the top, the arms or "blades" are attached by massive iron fastenings. These four giant arms describe a circle of over 160 feet, each wing being 82 feet long. The tower is so constructed that the huge wheel can be adjusted to any point of the compass, according to the direction of the wind.

At the top and bottom are beveled gears through which the power developed by the revolving wheel is utilized for driving the powerful pumps. The power, of course, varies with the force

of the wind; but the maximum strength developed is about 200 indicated horsepower, which is ample for driving the pumps at good speed. During the dry season it is necessary to keep the mill constantly pumping, to maintain the supply. During very heavy gales of wind, the mill is temporarily closed down.

San Pedro Breakwater

PERHAPS the most gigantic enterprise ever undertaken by the general Government on the Pacific Coast, is now in active progress at San Pedro, on the southern seaboard of California. The purpose of the Government is to make San Pedro Bay a safe harbor at all times, which it has heretofore been only during calm weather.

To this end the sum of $3,000,000 has been appropriated by Congress. This means the construction of a sea wall beginning at a point two-thirds of a mile off Point Firmin, and extending outward a long distance.

This wall is to be 14 feet above sea-level at low tide; it is to be six and four-tenths feet high, 190 feet wide at the base, and 20 feet across at the top. The bottom is of very rough rock, while the top is to have a superstructure of well-smoothed rocks, laid regularly but without mortar.

In constructing this gigantic breakwater, it was necessary to build out an immensely long trestle, on which a railroad track was laid. This double-track trestle has been gradually extended until to-day it juts out seaward nearly two miles. Rocks have been dumped from the cars for that entire distance, and still the work progresses.

A large pile-driver is the advance guard of the work. Along the trestle at intervals are giant cranes, by which the great ragged rocks are picked up and dropped at the proper places. These rocks weigh from eight to ten tons each. During the past year, 1,609,369 tons of rock have been placed along the great sea wall, on the substructure and superstructure.

Another vast improvement is being made to San Pedro Bay itself. The plan is to increase the depth of the present inner harbor to 25 feet at low tide, and materially enlarge the area. The estimated cost of this additional work is $2,000,000. When it is completed, the bay will have a channel 400 feet wide and a mile long. At the upper end, the inner two-thirds of a mile will be dredged to a mean depth of thirty feet, to enable vessels to turn about. The inner harbor, when dredged and widened, will have an area of about 1,200 acres—sufficient space for the navies of the world to ride at anchor in safety.

The San Pedro harbor improvements exceed in magnitude and cost the great canal and locks at the Cascades of the upper Columbia, or the immense jetty at the mouth of that river, both of which were completed some years ago.

San Pedro lies about 400 miles south of San Francisco by sea. Between the two ports there is no adequate harbor of

DROPPING STONES IN CONSTRUCTION OF SAN PEDRO BREAKWATER, CALIFORNIA.

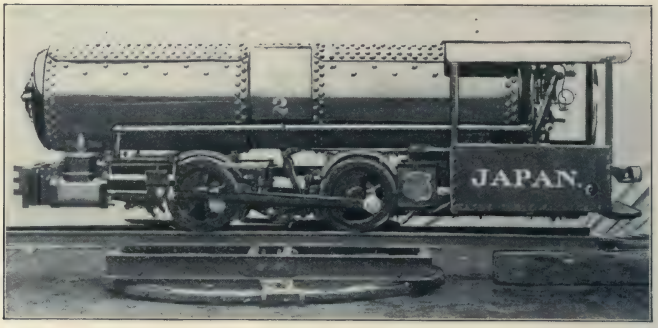


FIG. 1. PITTSBURG COMPRESSED-AIR ENGINE, AT YEZO COAL MINES, JAPAN.

safety. The improvements now in progress at the former point are of vast importance to the shipping interests of the entire Pacific Coast.

American Engines in Northern Japan

THE principal coal mines worked in the Japanese empire are located on the island of Yezo lying to the north of Nippon, the principal island of the Japanese group. It is an interesting fact that the mines are lighted by electric lamps made in the United States, and the current for lighting and power is generated by American dynamos. The mines are connected with the seacoast by a railroad laid out by American engineers and provided with American-made rails. In the principal mines, however, the cars of coal from the chambers are hauled to the mine elevators by compressed air, used by American locomotives also. The photograph here reproduced (Fig. 1) shows a type of one of these engines employed at the Yubari group of mines. It was manufactured in Pittsburg especially for the industry referred to, and has been in service several years. The Japanese also employ some American engines on the steam railway which connects the mines with the shipping ports. As will be seen (Fig. 2), these are of the eight-driver type. They weigh about forty tons, including the water tank, carried beside the boiler, and were built especially to develop tractive force as they are in service on heavy grades.

FIG. 2. PITTSBURG LOCOMOTIVE USED AT THE LARGEST COAL MINES IN JAPAN.

Tapping Trolley Wires

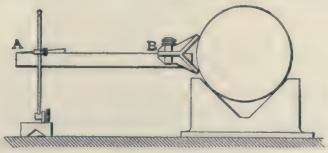
IN several cities of the United States the electric current from the trolley wire is utilized in a variety of ways besides operating the street-cars. The accompanying illustration is of a portable welding machine used for bonding the ends of rails. The current is taken from the

TAPPING TROLLEY-WIRE CURRENT FOR WELDING.

wire by a loop connected to the motors enclosed in the boxes. This mechanism produces the necessary heat. Some of these machines are provided with a parallel pole, and can be run along the track by their own motors, but the one here illustrated is drawn by a trolley car.

Finding Center of Shaft

THE height of the center of a large shaft can easily be found by the simple method shown in the illustration, without turning the shaft half way round, as is usually done. Apply the combination square to the side of the shaft, as shown; and bring both ends of the blade, A and B, to the same height by the surface gauge, and this will be the height of the center. This method can be used when the shaft is over the lathe centers, if a parallel piece or other level support is provided for the surface gauge. It will be found convenient, says C. W. Putnam in the *American Machinist*, to have a scratch on the tailstock spindle

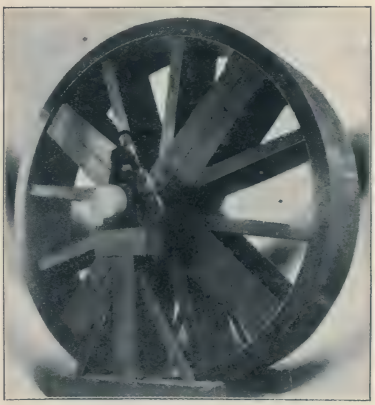


FINDING CENTER OF SHAFT.

and also on the front of the headstock, just the height of the center.

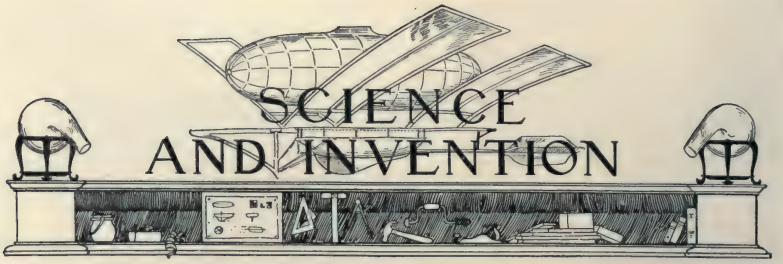
World's Largest Pulley

TWO HUNDRED and forty inches in diameter, 50 inches face, and mounted on a 12-inch shaft, a gigantic pulley—the largest ever constructed—which was exhibited at the St. Louis World's Fair by the Reeves Pulley Company proved one of the most attractive sights to machinists at the big show. The weight of the great wheel is more than 12,000 pounds. To build it, required the constant work of four men for thirty days. The pulley is soon to be put in regular service by the Reeves Company at Columbus, Ohio.



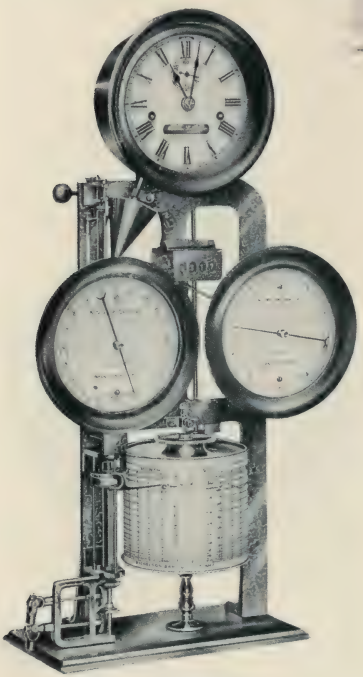
LARGEST PULLEY IN THE WORLD.

This immense wheel is built of Southern Indiana oak boards. It is made in halves, the arms being constructed of boards separated from one another by rim segments, between which they pass and form a portion of the rim.



Automatic Ship Log

SHOWING at all times the exact speed of the vessel, and permanently recording this speed, together with the time and date of the record chart, a new ship log that has been made in Cleveland, Ohio, is a radical departure from all other types of nautical measuring devices. It is called the "Nicholson" ship log in honor of its inventor. In addition to giving the mileage sailed, the log shows on a dial the speed per hour, and records this speed on a paper record chart for every minute of the trip. These records can be dated and filed away for future reference; and, should any accident or controversy occur, they would furnish incontestable evidence. The device is entirely automatic, and requires little attention save the daily winding of the clock and changing of the paper record. When the log's record chart is turned in to the steamship manager, he can see at a glance the entire performance of the ship while she was under way.



NICHOLSON SHIP LOG.
Showing Complete Automatically Registering Apparatus.

The complete registering apparatus is shown in the accompanying illustration (Fig. 1). The clock is placed at the top of the frame and works in conjunction with the speed dial, regulating the counter and record drum. The pointer on the dial to the left is operated by the speed of the vessel, and indicates the miles or knots per hour the vessel is moving. It is so sensitive that the slightest variations of speed are instantly shown. When the pointer completes a revolution, a figure is turned in the counter located between the dials. The drum carrying the paper blank form, is operated by the clock placed above the indicator dials, and shows a complete record of the speed for 24 hours, the hours being laid off vertically and the miles horizontally.

A simpler form of log, designed for use on rivers and harbors, has no counter attached, the distances traveled being always known.

A cross-section of a vessel with the log installed in the pilot house, is shown in Fig. 2. The 3-inch pipe *B* is known as the speed pipe; *A*, as the load level pipe. It is necessary for the latter to extend only a short distance above the deepest load line, and the same amount below the lightest load line, the small one-inch pipe shown being a protection to the driving chain *E*, which is attached to the ascending or descending float. The speed pipe starts at the same level as the pipe *A*, and extends as much higher

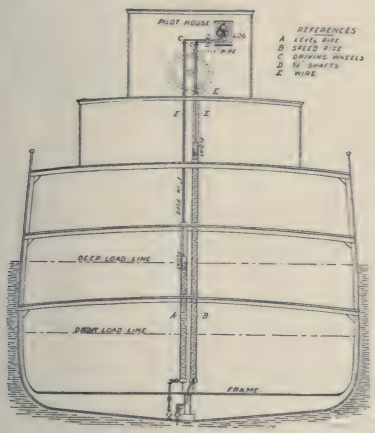


Fig. 2. Cross-Section of Vessel with Log Installed in Pilot House.

above the deep load line as the maximum speed of the ship requires. To the floats shown in the speed pipes *B* and the level pipe *A*, are attached chains, which run over sprocket wheels *C C* in the pilot house. To the end of the chains are attached counterweights, encased in a ¾-inch iron pipe.

When the ship is at rest, both floats will remain at the water line, keeping the registering apparatus at zero, regardless of any change in the load. As the ship moves forward, the water enters the intake tube at the bottom of the vessel, and flows into the speed pipe, raising the water column according to the rate of speed. When the vessel has reached normal speed, the float comes to rest and does not change unless the speed is increased or diminished. When the ship stops, the float will descend to the load

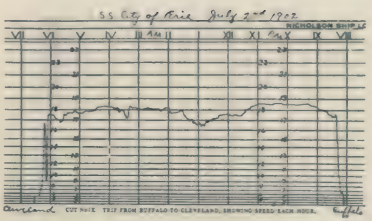


Fig. 3. Specimen Log of Steamer "Erie" on Trip Between Buffalo, N. Y., and Cleveland, O.

line. The log does not register when the vessel goes astern. Connecting the log with the sprocket wheels *C C* are the ¼-inch brass shafts *D D*. In the entire construction of the log, there is no metal used that will interfere with the action of the compass.

In Fig. 3 is reproduced a record taken from a regular trip of the steamer *City of Erie*, of the Cleveland & Buffalo Transportation Company. It will be noticed that every variation of speed is shown, as well as the time of starting and stopping.

Simple Fire Escape

ESCAPE from a burning building is apparently made a very simple proceeding through the invention of a new fire escape in Chicago, the city of the sky-scraper. On the alarm of fire, you simply slip the end of the rope over any solid projection; sit in the sling of the escape, and ride down, slow or fast as you desire, the speed, it is claimed, being always under perfect control. The operator simply handles the loose end of the rope which extends from the pulley. The rope cannot jam, it is alleged, and the apparatus cannot get out of order.

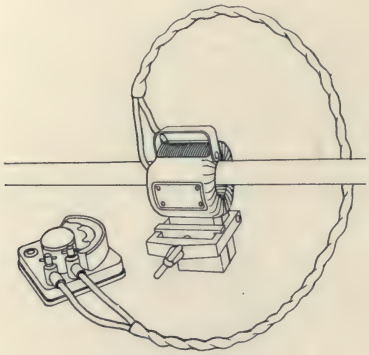
Simple Fire Escape in Use.

The device is known as the O. & L.

fire escape. It is small, and is simple in operation. The traveling man can tuck it away in the corner of his grip, and a woman can carry it in her handbag.

Cable-Testing Device

AN extremely ingenious device called a "Cable-Testing Current-Transformer Set" is manufactured by the General Electric Company. The object of this piece of apparatus is the measurement of an alternating current flowing in a cable, without the necessity of cutting and tapping into it to insert an ammeter. As shown in the accompanying illustration, the set consists of a special transformer having a hinged magnetic circuit and a standard inclined-coil portable ammeter. The clamp at the bottom of the transformer can be removed, and the transformer opened on the hinge at the top and then closed about the cable. Especial care has been taken with the joint at the clamp and hinge, to insure a good magnetic path.



CABLE-TESTING APPARATUS.

The current in the cable sets up a magnetic field, which induces a current in the secondary of the transformer proportional to the current in the cable. This can be read on the portable ammeter, which is calibrated to read in terms of the current in the cable.

The leads are sufficiently long to allow the placing of the ammeter in any convenient position. The winding of the transformer is of 5-ampere capacity, and is designed to withstand 2,300 volts' potential between it and the core. It is claimed that this transformer will maintain within commercial limits its ratio accuracy from ⅛-load to 25 per cent overload.

This testing set is valuable both in the laboratory and in commercial service, particularly in determining the load on feeders and distribution networks.

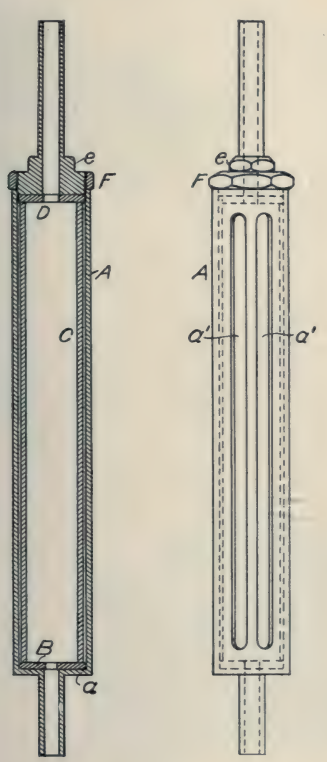
Camera Tricks

THE accompanying photographs show potatoes and corn of truly marvelous size; but it might be well to state that the effect is produced by manipulation of the camera rather than as the result of cultivation by the farmer. Each picture really represents two views taken at different distances, but so combined that in one case the potatoes seem to be as large as flour barrels, while in the other the ear of corn is of the dimensions of a tree trunk. The views were taken by a Texas photographer in order to advertise the agricultural advantages of his section.

THE PRODUCTS OF NO MAN'S LAND.
Ingenious Exaggerations Produced by the Camera.

Water Gauge

THE accompanying sketches show a new water gauge recently patented by Mr. W. R. Malcolm, Albany, N. Y. The invention consists primarily of a water glass and guard combined, the object being to produce a gauge which is not easily broken.



WATER GAUGE.

As shown in the drawings, *A* represents an outer casing or shell, provided with vertical slots *a'a'*, and a reduced lower end on which is formed a ledge *a*. On this ledge is a washer *B* of a yielding substance, preferably of lead. The glass tube *C* is arranged within the casing *A*, and its lower end rests on the washer *B*. A corresponding washer *D* rests upon the upper end of the glass tube *C*. The drawings show clearly how the nut *F* screws onto the head *e*, holding the glass firmly.

The inventor claims that steam is prevented from getting on the outside of the glass, and thus many breaks, which are due to the glass becoming thin by the action of steam, are prevented. A further advantage is that no strain is brought on the glass if the gauges in the boiler are not in line, since the joints in the valves are independent of the glass.

Carley Life-Float

SO light that two men can toss it from the ship, and so buoyant that it will support half a hundred persons, a new life-saver that was recently tested off the Romer shoal north of Sandy Hook, proclaims itself one of the most efficient devices of the kind ever invented. It is the invention of Horace Carley, an old-time sailor, and is called the "Carley life-float." The principal mechanism consists of an elliptical, covered, copper tube with many air-tight compartments strengthened by flanges or fins. The copper tube is covered with two inches of compressed cork : nd is wound with canvas. The whole is made absolutely waterproof.

A rope netting three feet deep is at-

CARLEY LIFE-FLOAT.

tached to the inside of the cylinder. This suspends a slatted wooden bottom that travels on rings inside the lashings. Inside this elliptical device the shipwrecked persons stow themselves, and

paddle to shore or float about in the water until rescued. It is impossible to sink or capsize the float; and its occupants do not have to struggle with all their might to keep from being washed off a wave-topped surface, as in the case of life-saving rafts.

A Gigantic Log

THE Pacific Slope is noted the world over for its magnificent forests. These consist mainly of conifers—pine, cedar, hemlock, spruce, and other trees—many of which attain enormous size and tower aloft for hundreds of feet.

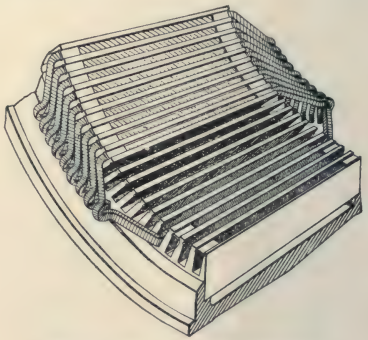
Recently a giant yellow fir tree was found in Clatsop County, Oregon, by loggers working at Blind Slough. This venerable king of the forest was felled; and the butt section is here shown lying on an iron platform car. The tree was perfectly sound throughout.

The log was 28 feet long, 110 inches in diameter at the butt, and 95 inches in diameter at the upper end. It weighed over 23 tons, and contained 12,000 feet of lumber, board measure. The tree from which it was cut was 431 years old, and rose to a height of 200 feet without a limb. Seven sections of this tree which were logged, yielded together 40,000 feet of lumber. The log in the picture was cut into first-class flooring, which sold at $30 per thousand feet and realized $360.

ENORMOUS YELLOW FIR LOG.
A Specimen Product of the Forests of the Pacific Slope.—Contained 12,000 feet of lumber, valued at $360.

Electric Coil Retainer

A SIMPLE method of retaining electric coils in proper position, has been invented by Isaac D. Kaiser. A laminated-iron core is held in a cast frame, and comprises annular sheet-iron punchings having inwardly projecting teeth, between which are slots for the coils. The sides of the teeth adjacent to their free ends are provided with grooves, which extend inwardly from the ends of the core, a short distance only; the beveled edges of small fiber strips are fitted tightly into these grooves after the coils are in place. The cross-sectional area of the ends of the teeth is not reduced except at the extreme ends of the core.



COIL RETAINER FOR ELECTRIC MACHINES.

Life Stories of Successful Men

Meyer Guggenheim and His Seven Sons

By HENRY M. HYDE
Author of "The Buccaneers"

IT reads like an old-fashioned fairy story—this plain and simple record of a Jewish emigrant from Switzerland, who spent four months in coming across the ocean in a tramp sailing ship, who started life in this country by selling stove-polish, who became interested in various businesses, and who, with his sons, now controls one of the most important industries in the United States.

It is a fairy story. And the good fairy of the plot is the same never-satisfied desire for exact and thorough knowledge which has marked the character and the career of so many captains of industry. The reason why Meyer Guggenheim, in defiance of business rules and principles, made a success of so many different lines of business, is found in the fact that he always insisted on getting an accurate technical knowledge of each one of them as soon as he entered it.

Meyer Guggenheim was born in Lengnau, Switzerland, February 1, 1828. He lived there in the old home through his boyhood, and it was not until he was nineteen years of age that he finally started for the land where he was destined to make a great fortune. He was then, as he is now, a slight, short man, with a presence that carries no overwhelming sense of power. The casual observer would have said that he had nothing in his favor. But the casual observer could not have seen the qualities which drove him resistlessly ahead to a great success. The first of these qualities was industry. Immediately upon leaving the ship at the dock in Philadelphia after the tiresome voyage of four months, he started out to sell stove-polish through the country surrounding Philadelphia.

At Bethlehem, Pa., young Guggenheim made the acquaintance of a chemist. He wanted to know what that stove-polish he was selling was made of; and he knew that the chemist could tell him. Meanwhile he was making a good profit on his sales. Presently his burning desire to get at the bottom of things was satisfied, so far as the polish was concerned. His friend, the chemist, analyzed it; and Guggenheim found that he could make the commodity himself for much less than he was obliged to pay for it at wholesale. So he began to manufacture stove-polish, and to sell his own product at a greatly increased rate of profit.

A little later he became interested in concentrated lye. He found that there was a good market for this product, and a good profit in its sale. But that did not satisfy him. He sat down and learned all there was to know about the lye business, from the buying of the raw material to the best formulas for its manufacture. In a comparatively short time he was making and selling as good a brand—and perhaps just a little better brand—of concentrated lye than anybody else had to offer.

Then came other ventures, and in each of them Guggenheim was more or less successful, simply because he never rested until he knew the new business from the ground up. Finally he worked into the importation and sale of embroideries. From his earliest boyhood he had been somewhat familiar with the manufacture of white goods and embroideries, which was one of the leading industries of his Swiss birthplace; and it was only natural that when he had accumulated considerable capital and more business experience, he should go into that line of work.

Once again he demonstrated his complete belief in the principle that thorough technical knowledge lies at the foundation of commercial success. But this time he

did not undertake to learn the lesson himself. He sent one of his sons abroad to master the technical side of the business, while he, removing his headquarters to New York, undertook the management of the selling end.

Away back in 1847, during that four months' voyage across the Atlantic in a sailing vessel, he had met a young girl who was coming to America with her parents. The young people found plenty of time on the trip to fall in love with each other. But they had discretion enough to wait until young Guggenheim was on his feet financially, before they were married. Five years after the landing in Philadelphia, the wedding was celebrated; and when the head of the family was ready to start in the embroidery business, they had a big family of seven sons and several daughters growing up around them. It was one of the eldest of the sons who was sent to Switzerland in his father's stead, to study the design and manufacture of embroideries. Some of the other sons were taken into the firm; and the new venture, into which practically the whole family put its best energies, prospered exceedingly. Out of it, Meyer Guggenheim made his first large accumulation of wealth.

When he was already a middle-aged and wealthy man, a business friend came to Mr. Guggenheim, and wanted to borrow some money for the development of a promising mine in Colorado. Mr. Guggenheim was not willing to advance the money unless he could go into the deal as a partner. The mine turned out poorly. There was plenty of ore, but even more water, and it looked for a long while as though the whole enterprise was destined to be a complete failure. But Meyer Guggenheim was not accustomed to be connected with failures, and he did not propose to begin at this period of his life.

MEYER GUGGENHEIM.

The embroidery business was so well organized that it would take care of itself

for a while under the direction of the boys. So he simply packed up, and went out to the mine to see for himself what was the matter. There he asked innumerable questions, studied for himself the problems which had baffled the managers, and presently began, as his critics said, to throw good money after bad in the purchase of new machinery and the sinking of new drifts. But the result was that in a little while the mine began to make a profit; and, before some people had recovered from their surprise, it was a handsomely paying property.

Nor was that all. Meyer Guggenheim's investigations had convinced him that there were great profits in the mining business, if properly conducted. He had been especially struck with the fact that the business of smelting was a good one. So he went to work again on the same old principles which had proved successful in so many other ventures. He bought some stock in a Denver smelter, and at the same time sent one of his seven sons to a technical school to master thoroughly the scientific side of smelting and metallurgy. When the young man had taken his course, Meyer Guggenheim wasted no time. With the aid of his son's technical knowledge, he designed and had built an enormous smelter, costing about one million dollars and containing all the latest and most improved devices for doing the work better than before as well as more economically. Presently, all of the seven boys were taken into the smelting business, and the firm of M. Guggenheim's Sons was organized, the senior retiring from active participation in the business, though he has always remained the court of last resort in all the affairs of the firm.

Since then the firm has built several other large smelters, and has added to its holdings many rich mines in the West and in Mexico. To-day it is the largest factor in the smelting trade of the United States, and has to be reckoned with in the metal markets of the world.

Meyer Guggenheim has always been the severest critic of all his sons' business policies. He has insisted that everything they do must be based on as complete and thorough a technical knowledge as it is possible to acquire. At the same time, his "boys" are his greatest pride. And the young men—some of them well advanced now towards middle age—have always returned his paternal affection to the utmost.

Nowhere could there be found a stronger demonstration of the fact that, in the modern world of business, knowledge is still power. And if this lesson seems to be repeated over and over again as one studies the life work of successful men, it is only because the will and the determination to acquire exact and thorough knowledge in their several lines seems to lie close to the secret of their astonishing success. It was this determination to know "why the wheels go round," and the ability to apply that knowledge, once it was acquired, which have been the chief factors in raising Mr. Meyer Guggenheim, who started his business career so lowly in 1848, to his present unique position as the man who wrought out, built up, and still maintains, with his family of seven strong business men, a great branch of one of the most important of the technical industries of our country.

WHERE HISTORY

Birthplace and Home of Asa Pollard, the first man to fall on the American side at the Battle of Bunker Hill. This house is still standing in practically the same condition as originally. It is located on the road from Lexington to Lowell, in the town of Billerica. Asa Pollard was one of the Minute Men, but it is not known whether he participated in the Battle of Lexington or not. Some Minute Men from Billerica did take part in that battle.

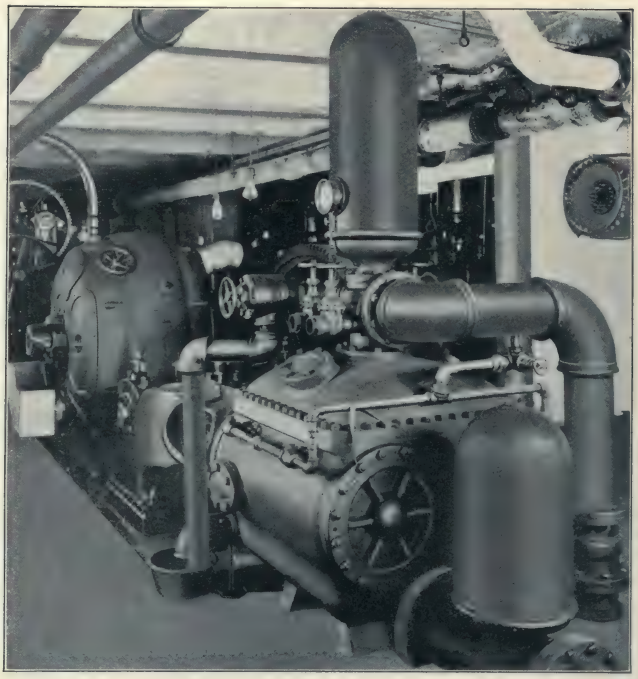
Old Powder House, Somerville, Mass. Built prior to 1720. When first built it was a windmill. Sold in 1747 for a magazine. General Gage, commander of the British troops in Boston, seized the powder stored there in 1774. In 1775, soon after the Battle of Lexington, the American Army gained possession of it, and stored their powder there for a number of years. The relic is now owned and preserved by the City of Somerville.

WAS MADE

The Plymouth Lindens, Plymouth, Mass. In 1750 a shipmaster named Cameron brought to Plymouth from England in a raisin box a few rooted slips of the English lindens. Of these slips, three were planted by Col. George Watson, then a prominent resident of Plymouth. From slips taken from these trees, the row now standing along the street were planted. In 1760 they were about 15 feet high. At the present time they stand 80 feet in height, and are from 10 to 14 feet in circumference four feet from the ground. The trees are well known to tourists visiting the historic town where some of the foundation stones of popular liberty were laid; but they have seldom been photographed.

The Harrington House, Lexington, Mass. There is no definite knowledge of the year in which this house was built, but it was standing at the time of the Battle of Lexington in practically its present condition. Its situation is on the left side of the Lexington Common. Directly in front of it stood a part of the Minute Men at the time of the battle, April 19, 1775. The owner, Jonathan Harrington, one of the Minute Men, was wounded at the first discharge of British firearms. When shot he was running from the meeting house, where he had gone to get powder. He dragged himself to the door of the house, and died at his wife's feet.

FIRE APPARATUS INSTALLED IN A GREAT DEPARTMENT STORE.



Fire Departments for Single Buildings

A Valuable Principle Capable of Wide Application Suggested by a Recent Installation in the Great Retail Department Store of Marshall Field & Company, Chicago, Ill.

By AYLMER JACKSON
Mechanical Engineer

A FIRE DEPARTMENT for every building seems to be the tendency resulting from the erection of the tall and huge commercial structures of our modern cities. An ideal installation of the kind has recently been placed in service in the great retail establishment of Marshall Field & Company in Chicago, the largest store in the world. With equipments like this established in every large building, great fires such as recently devastated Baltimore and Toronto would be practically impossible. Even with the private fire-protection apparatus that was installed by commercial houses in those cities, the spread of the flames was checked and many buildings saved. It is estimated that the property saved in each of these cities by such equipment, amounted in value to $5,000,000. Private fire apparatus is always on the ground ready for duty; while the city fire companies have to make runs from their stations, arrange their hose lines, make the necessary couplings, etc. A

bucket of water in time may extinguish a fire that a whole fire brigade could not quell in another ten minutes.

The apparatus at the Field store consists of a Laidlaw-Dunn-Gordon duplex Underwriter pump connected by single-reduction gearing to a waterproof electric motor. The pump cylinders are 8 inches in diameter, with 12 inches' stroke, having a theoretical capacity of 700 gallons per minute at 600 revolutions per minute against 140 pounds' water pressure. The motor is shunt-wound for 220 revolutions per minute at 230 volts, and is inclosed, all connections being carried through pipes screwed into the frame, so that the device may be flooded without affecting its action. The fields and armature coils are cooled by fans on the armature shaft.

Lay Excursions in Science

Third Paper

By CHARLES PIERCE BURTON

Author of "The Bashful Man and Others"

THERE is an old saying that "fools rush in where angels fear to tread." This possibly accounts for these "lay excursions" into the field of science. At any rate, I am satisfied in my own mind that angels would fear to tread on microbes. Yet, here am I, although with many misgivings, venturing on this great subject of germs, little understood by myself or by anyone else.

One of the most astounding developments in the past remarkable decade is the rapid manner in which the microbe has come to the front. A few years ago he was practically unknown; he was not even given honorable mention in encyclopedia or dictionary. To-day every self-respecting encyclopedia devotes pages to this most interesting organism; and there is not a dictionary in the land, of any age or experience whatever, which is not filled with a choice assortment of microbes from one cover to the other. That this, the smallest of organisms visible to the scrutiny of the microscope, should become at a bound the most stupendous thing in nature, may well cause wonder.

Nor does the microbe's ambition know any limit. He works over-time, entering into human affairs with a persistence and success that is simply astonishing, not to say alarming. In a few short years he has achieved an international reputation, becoming the world's bugbear, the accepted scapegoat for all the sins of mankind. Ah, poor microbe! An ungrateful public, forgetting thy benefactions, wages relentless war for thy extermination. Weak and frail creatures that we are, were we not made a little lower than the angels? Yet, violating repeatedly half the laws in nature's category, physical and spiritual, we learn no wisdom, but attribute all our misfortunes to those invisible, inconceivable microbes.

Possibly these, the most feared, the most abused, and the least understood of living things, need not our pity, nor yet our defense. It must be confessed that the microbe has always shown an independence of action and an ability to take

care of himself under any and all circumstances which must command respect, even from bitterest foes. But the very stones, the dust of the earth, communion cups, and telephone receivers—yea, the ruby lips of blushing maidenhood—cry out for justice. And shall we remain supinely by, refusing to see that justice is done, because, forsooth, public opinion is against us?

The microbe is nothing to me. I have no special interest in his welfare. Yet, when this creature, thing or monstrosity, is accused of going up and down the land burning haystacks and barns on top of all his other alleged outrages against humanity, is it not time to call a halt? According to a high authority, an incendiary microbe devotes himself to spontaneous combustion in the hay-mow, with disastrous results to the owner of the hay. How unfortunate that these interesting parasites are not visible to the naked eye, because there seems no possibility of dodging them. Like the poor, they are always with us, but give us more trouble than the latter.

The microbe was a wonderful discovery. We accuse him of causing our baldness, our fevers, our diseases of all kinds, until we fain would build a dust-proof, air-proof, microbe-proof house, and retire from mortal gaze, safe from the devastations of unscrupulous bacteria. But we forget the great part played by the microbe in nature. He gives us death, but so also does he bring us life. Our very digestion is said to be the result of his industry. He poisons our drinking water; but the toper owes his beer to the microbe; and the epicure, his wine. The commonest wine microbe, according to the late lamented Pasteur, is *Saccharomyces ellipsoideus.* I mention this fact that it may not be confounded in the popular mind with the *Cryptococcus vini,* which has nothing to do with alcohol—never touches it, much to its credit.

Perhaps he does cause our baldness and burns our barns, but he clears the surface of the earth of the refuse of life, and makes other life possible. Microbes float in the air we breathe, in the water we drink; not a day passes in which we do not come into contact with them both internally and externally; yet our very bread and butter and the flavor of our meats depend upon them. The effect of microbes in making bread digestible has long been known to housewives. Now it is claimed that bacilli are necessary in the manufacture of first-class butter. Many creameries inoculate their cream with the butter microbe, better known as "Bacillus No. 41," and produce June butter in January. It is said that the patient experimenters tried over one hundred different microbes before they could find one fit to eat.

The question naturally arises—What is this thing which worketh from life to destruction, and from destruction back to life again? What is this modern scapegoat of science of which we are all afraid? What in all creation is the microbe anyway, a thing which we never saw, yet accept with a faith that is truly sublime and, turned in the right direction, might remove mountains? The borderland between plant and animal life is the land of the microbe. Science at first accused him of being an animal. Now it is said that he is not an animal at all, but a plant. It does not matter. The microbe seems to have come to stay, regardless of consequences. Hats off to him! He is no more a mystery than is his would-be critic; for of all the mysteries of nature, man is himself the chief.

Chicago's Traction Project

FIFTY MILLION DOLLARS are to be expended in giving to Chicago the ideal tunnel system of America. Leading Chicago and New York capitalists, headed by James Stillman, president of the National City Bank of New York City, are behind the project. Already tunnels have been dug under all the principal downtown streets of Chicago, presumably by the Illinois Tunnel Company, for the purpose of inaugurating an underground freight railway system. It is now believed that this same assemblage of wealthy capitalists, representing a financial power of eleven billion dollars, have been at the back of the scheme since its inception. Through the National City Bank's twenty-four directors, this institution is represented in the directories of 357 other important concerns, including railroads and insurance companies, as well as banks and trusts. All four of the known promoters of the Chicago Subway company are directors of the National City Bank. Mr. Stillman has E. H. Harriman, Jacob H. Schiff, and P. A. Valentine as colleagues in that directory. This makes the Chicago Subway company a peculiarly National City Bank enterprise.

A two-story tunnel system will be the result when the ultimate plans are carried out. The scheme contemplates traffic arrangements that will succeed in solving Chicago's traction problems for all future time. Improvements and additions are to be made commensurate with the city's growth. For the present, efforts are to be concentrated on carrying out the plan already begun, of removing all heavy freight traffic to the underground thoroughfares. The loads now hauled to and from the depots in heavy, plodding, menacing freight-trucks, will be hauled in the subway by means of underground electric freight trains. This is another blow at the horse, whose sphere of usefulness in the Western metropolis will thereby be greatly diminished. At present the heavy freight trucks and their kind are the greatest hindrance to Chicago's traffic. They monopolize the streets in the business centers, block the street-cars, hinder automobile and light vehicle traffic, and often, in the event of a breakdown, tie up the city's traffic on certain streets for hours at a time. All Chicagoans know the inconvenience of what it means to have a heavy coal wagon break down on a street-car track.

The present arrangements plan for having all this kind of haulage done underground, and for reserving the light and air of the street surface for the people. Chicago will be the only city in the world to have this kind of arrangement, other great cities having deemed it advisable to haul the people underground, and to reserve the streets for hauling coal, provisions, and all kinds of heavy freight.

In a short time, however, with Chicago's rapid growth, the streets are destined to become over-congested from passenger and pedestrian traffic alone, even with the freight wagons removed. Then it will be that the second story to the subway—which probably will already have been built—will be brought into service. Then underground passenger cars will be run in addition to the surface cars, as in New York, Boston, London, Paris, and Berlin; but in addition to the passenger subway, Chicago will have the freight subway to alleviate the traction difficulties.

In this project, Chicago will undoubtedly have the ideal traction system of the world. For, in addition to the freight tunnels, passenger tunnels, and surface cars—three stories of traffic one above the other—there are the elevated trains, adding still another story, and the numerous suburban trains, which hurry passengers to and from nearly all sections of the city on schedules of from two to twenty minutes apart. The freight tunnel now being built is also to

be used for stringing telephone wires and laying tubes for the new pneumatic tube service that will take many delivery wagons from the streets.

Transplanting Trees

THERE are several methods by which whole forests can be dug up if desired, and taken from their original site to adorn parks and private grounds. In the vicinity of New York City can be seen grounds ornamented in this way, being not only covered with flower beds and flowering shrubs, but shaded with full-grown trees, where not long ago nothing in the way of vegetation existed except grass and weeds.

The apparatus used for taking up and transplanting trees is aptly termed the "tree mover." In operating with one form

TRANSPLANTING TREES.—CUTTING AROUND ROOTS.

of this apparatus, the tree is dug by starting a circular trench having a diameter of thirty or forty feet. An under-cut is made beneath the roots, and the soil picked out and caved down with a spading fork or picking rod, the points of which are rounded to avoid cutting off the roots. The loose dirt is shoveled out of the bottom of the trench, and the roots are uncovered, tied in bundles with lath yarn, and bent up out of the way of the diggers. If the roots are to be out of the ground even for one day in dry weather, the bundles are wrapped in clay mud, damp moss, and straw or burlap. When the digging has progressed to within from four to eight feet from the center, the tree is slightly tipped over to loosen the central ball, which cleaves from the subsoil near the extremities of the downward roots. In the center is left a ball of earth five to twelve feet in diameter.

In loading for removal, the cradle of the mover, which is pivoted above or back of the axle, is swung over to the tree, the trunk first being wrapped with cushions and slats so that it can be clamped to the cradle by chains and screws without injuring the bark. By means of a screw nine feet long, operated by a ratchet lever or hand-brake wheel, the cradle lifts the tree from the hole and swings it over in a horizontal position. Pulling in the same direction by tackle fastened in the top of the tree, aids the work of the screw. After the tree is loaded, the roots on the other side of the axle are tied up to the perches, and it is then ready to be taken away.

Another plan, devised by a Western inventor named Wilkens, is even more ingenious. The apparatus consists, first, of a steel platform from 4½ to 6 feet in diameter, fitted around the tree and securely bolted. This is equipped with a properly arranged steel guide, through which the steel concave shovels are driven down around the platform by use of a maul. The shovels are sharp and have corrugated edges so that when driven down they cut off all roots that project beyond the circle desired to be taken up. When the shovels are all in place, they are secured to the platform by means of a steel ring and locks. The roots of the tree, together with the earth in which they grew, are thus confined in a sort of steel basket.

The transporter, which also plays an important part, is ingeniously constructed of steel and is circular in form, having an opening in the rear. After the machine is placed about the tree, the opening is securely closed; and, by means of properly arranged pulleys and ropes, two men can lift the basket with the tree and earth to the required height. Then, by the same power, the tree is laid back upon the cushion of the transporter, and is now ready for removal. No strain of

Carrying Tree to New Location.

any kind is put upon the tree. The bark and fiber are not injured.

When the tree has been transported to the desired point, it is placed over the hole where it is to be planted, in such a manner as to plant it in exactly the position in which it grew as to the points of the compass. The tree is then placed in an upright position by means of the hoist, and the basket is lowered into the ground. While still held in proper position, rich soil is placed about the basket and properly tamped. The shovels are then removed, one at a time.

Oklahoma's Claims to Statehood

Judged by every standard that measures not only future possibilities, but present attainments, Oklahoma has to-day all the indispensable requisites of Statehood. Though the development of the Territory since its organization in 1889, has been one of phenomenal, almost unexampled, rapidity, it bears every evidence of intelligent direction and permanent stability.

In 1890, when the first census was taken, the population was a bare 60,000. This has now increased to about 650,000. Thus, since the census of 1900, when the inhabitants numbered 398,331, the numbers of the population have nearly doubled; and even in that year Oklahoma had more inhabitants in proportion to area than twelve other Commonwealths included in the galaxy of established States. During the past five years the increase in any two-year period has been not less than 35,000; and in one instance (1900-02) the increase was over 143,000. This rate of growth is unequaled in the history of any other Commonwealth covering a similar period of time.

The immigration into Oklahoma has been chiefly from the States lying to the east and north; and it has been of a class of people marked by indomitable energy and enterprise, who have been attracted by the records of success in establishing homes and acquiring competences that are in this land of rich resources the sure reward of honest effort.

The great bulk of the population are American-born, the foreign element up to the present time numbering not over five per cent. The percentage of illiteracy is still less, the educational system being of the most progressive and efficient stamp. The Indian population is only about 12,000, including children, and is gradually decreasing. The colored population is most numerous in the southern and eastern portion, having immigrated from neighboring States, but is hardly in evidence in some counties, such as Kiowa, Woods, and Greer.

The social atmosphere is characteristically western in its spirit of open hospitality and good-fellowship, and is particularly noticeable to the stranger. It induces a cordiality of feeling and community of interests that foster business enterprise and the upbuilding of social and political institutions. The character of the citizenship is of the best, and crime and lawlessness are much less in this Territory than in many older members of the Union.

With its inexhaustible natural resources, its 650,000 of intelligent American citizens, its attained wealth of $400,000,000, its efficient colleges crowned by seven institutions of higher learning, its progressive spirit and persistent energy which within a wonderfully short period of time have transformed its sturdy childhood into the full stature of responsible manhood, and which contain the germs of still more brilliant promise, Oklahoma is even now *de jure* a full-grown member of the sisterhood of States, and is amply entitled to a *de facto* recognition of that status.—Alfred S. Johnson in *The Land of Now*.

In order to receive attention, all inquiries must be addressed to the Consulting Department, and must be accompanied with the *full name and address of the sender*. In view of the fact that the inquiries already received have far exceeded the available space, the Editors reserve the right to select for publication only those inquiries likely to be of greatest interest to the readers of the magazine in general. Other inquiries will be answered by letter.

Pressure Indicated by Water Gauges

Question: The question I should like to ask you is in regard to Syphon Gauges or Water Gauges, where the pressure is measured in inches. *(a)* How many inches in a pound pressure? *(b)* Supposing there were 24 inches against atmospheric pressure, how many pounds would there be to a square inch? *(c)* How many inches make a pound in pulling a vacuum on the same gauge?

Question (*a*) came up recently in our shop; and the answers were:—25 inches to pound; 6 inches and a fraction; 5 inches; and 2 inches, to pound of pressure.—*H. McD.*

Answer: One pound pressure would indicate a height of 2.3094 feet on a water gauge at ordinary temperatures. This is equivalent to 2.3094 × 12 (= 27.71) inches. Expressed in another way, one inch of water at 62° F. is equivalent to a pressure of .036085 pound per square inch. From this, we find the pressure equivalent to 24 inches, to be 24 × .036085 (= .866) pound. The pressure registered by the water column is the same whether the column is connected with a vacuum or with an atmosphere of greater pressure.

High-Speed and Self-Hardening Steels

Question: Will you explain to me just what is meant by the terms "high-speed steel" and "self-hardening steel?"—*M. L. S.*

Answer: Broadly speaking, the term "high-speed steel" includes all those steels which can generally be run at a higher periphery speed, and cut harder metals, than the ordinary carbon steels. In order to accomplish these results, a steel is made containing other metals besides iron. To distinguish them, they are called "alloy" steels. A high-carbon steel alloyed with other hardening ingredients will be found more efficient for machining chilled iron than the regular high-carbon steel. If the amount of certain hardening elements be increased to a given point, the steel hardens when heated red-hot and exposed to the air. This is called "air-hardening steel," although it is generally known as "self-hardening steel." As a rule, these steels are more easily injured by fire than carbon steel; and consequently, extreme care must be exercised when working them. As the nature of steel of this character depends entirely on the amount and kind of the alloy used, and the amount of carbon present, no fixed rule can be given for the treatment.

Thomson High-Torque Induction Meter

Question: Will you please explain the action of the Thomson high-torque induction meter? —*I. E. M.*

Answer: The high-torque induction meter is of the single-disc type, having two damping magnets as in the Thomson recording wattmeter. The static portion

of the meter element occupies the back portion of the case, and is magnetically separated from the damping magnets and the shaft mechanism by a magnetic shield, which serves jointly with the iron case and the cover to protect the damping magnets completely from any stray fields incident to heavy load or from short circuits that might otherwise tend to weaken the damping magnets and impair the accuracy. This shield also plays an important part in the general behavior of the meter.

The necessary torque or inductive-load accuracy has not been sacrificed to lightness and compactness, although both size and weight have been reduced as far as possible.

The case of this meter is removed directly toward the front. It is made of cast iron finished in black enamel, and rests upon felt packing against the back frame, to which it is securely bound by two wing nuts.

The register is of the "no constant" type, having five indicator hands like all Thomson recording wattmeters. The readings are uniform with those of the Thomson recording wattmeter, and may be recorded and tabulated upon the same system. The binding-posts are located at the bottom of the meter in a convenient position. Access may be had to them by opening a small cast-iron lid in the base of the meter.

This meter is manufactured for both two-wire and three-wire systems; and current transformers are not needed except with sizes in excess of 150 amperes two-wire, and 75 amperes three-wire. The induction meter is in reality a modified form of induction motor.

Kerosene Oil in Boilers

Will you please answer the following questions through the Consulting Department of your magazine?

Question 1: Is kerosene oil a good resolvent of scale in boilers?

Question 2: Is it best to put in a small quantity from time to time, or to put it in by the use of a kerosene injector?—*E. S.*

Answer 1: Kerosene is recommended and is used for loosening the scale, and also for preventing the formation of scale. In practice it has given good results.

Answer 2: As to the best method of feeding the oil—this depends somewhat upon the conditions. Ordinarily the best results are obtained by feeding little and often. However, if the total amount decided upon is very small, it would perhaps be sufficient to send it to the boiler through the feed water once a day.

Inside and Outside Admission Piston Valves

Question 1: What is meant by "inside" and "outside" admission when referring to piston valves on marine engines?

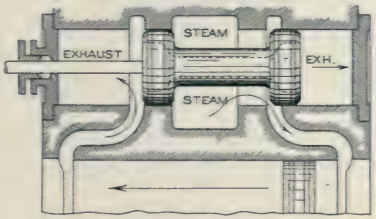


Fig. 1. Inside Admission Piston Valve.

Question 2: Why is it that on a triple-expansion engine having piston valves the high-pressure and intermediate-pressure cylinders have inside admission valves, while the low-pressure cylinder has an outside admission valve?—*J. L.*

Answer 1: In the accompanying sketches are shown the types of valves you have mentioned. In Fig. 1, the steam is supplied to the middle of the steam-chest, and is exhausted from the ends. This type is called "inside" admission, since the steam enters the cylinders over the inside edge of the ports. In Fig. 2, the steam is supplied at the ends of the chest, and is exhausted through the middle of the chest. This represents the "outside" admission, and is so called because the live steam, on entering, goes over the outside edge of the port. This latter arrangement is very similar to the ordinary simple slide valve.

Answer 2: The advantages of the inside admission are that the supply and

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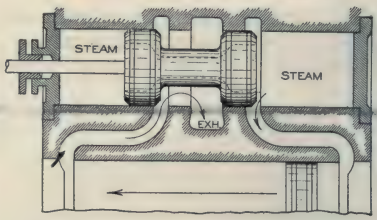

FIG. 2. OUTSIDE ADMISSION PISTON VALVE.

exhaust steam are well separated, and thus heat cannot pass easily from one to the other. Further, the valve-rod stuffing-box is exposed to the exhaust steam only, and consequently there is less trouble experienced with the stuffing-box. The inside admission, however, is not used for the low-pressure cylinder, since this arrangement is not desirable for a cylinder in which there may be a vacuum. The reason for this is that the leakage past the stuffing-box, in the case of a vacuum in the cylinder, would be inward; and the air thus entering the cylinder would be more troublesome than the escape of steam.

Pressure in Gas Engines

Question: I should like to know a little more of the gas engine:—

1. How many pounds' pressure to the square inch is the compression in a gas engine?
2. What is the ratio of compression?
3. What is the pressure of the explosion, at end of compression stroke?
4. What is the thickness of the cylinder?—*W. J. B.*

Answer: 1. Owing to the decrease from atmospheric pressure in the indrawing charge of the cylinder, caused by valve and frictional obstruction, the compression seldom starts above 13 pounds absolute. The pressure at the end of compression will depend upon the percentage of clearance. In various engines this pressure will run from 40 to 100 pounds, gauge.

2. The ratio of compression varies from 3 to 5, about 4 or 4½ being common practice.

3. Ignition usually takes place near the end of the compression stroke; and the pressure developed after this de-

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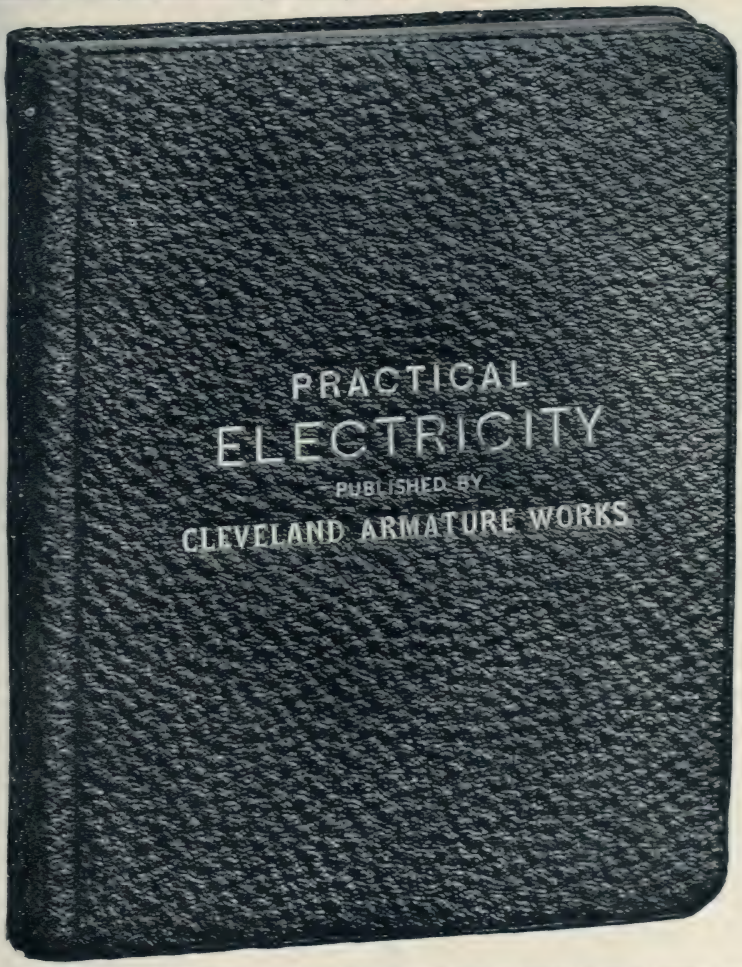

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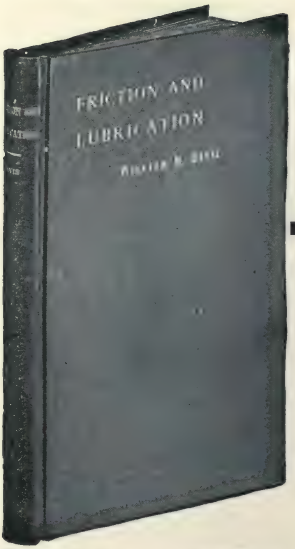

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pends upon the working fluid, the ratio of the mixture, compression, etc. Ordinarily this pressure will vary from 140 to over 300 pounds. In the Diesel engine, pressures of over 500 pounds have been recorded.

4. The thickness of the cylinder will, of course, depend upon the dimensions of the cylinder as well as on the kind of working fluid and the pressure to be used. In small-sized gas engines, the thickness is about ½ inch. An engine of 50 horse-power would require a cylinder about 1 inch thick; and larger sizes, in proportion.

Spontaneous Combustion—Noise of Electric Spark—Wood for Xylophone

Question 1: What causes spontaneous combustion?

Question 2: What causes the noise from the spark of an induction coil?

Question 3: What kind of wood is used in a xylophone?—*E. G. B.*

Answer 1: The most common example of spontaneous combustion is that of oily waste. Combustion is, of course, simply a combining with oxygen. In the case of oily waste, the oil is divided up into very fine particles, so that for a given quantity there is an enormous surface exposed to the air, and consequently oxidation takes place. This causes a slight increase of temperature, and this increase of temperature increases the oxidation until at last the temperature becomes sufficiently high to produce a fire.

Answer 2: The noise produced is due to the same cause as is thunder. The spark heats the air in its path, causing sudden expansion and compression thereabout, which is followed by a sudden rush of air back into the partial vacuum thus caused, and this causes the sound referred to.

Answer 3: In the construction of a xylophone, the best material to use is red birch or rock maple. It must, of course, be thoroughly dry to get the proper ring. The mallets may be made of the same wood and spring-brass wire used to fasten the head to the handle.

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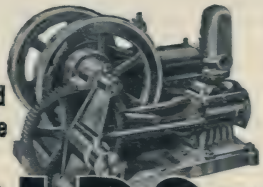

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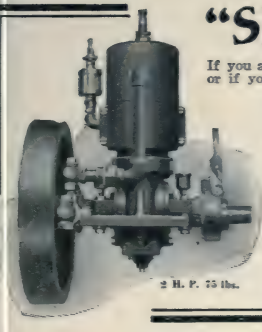

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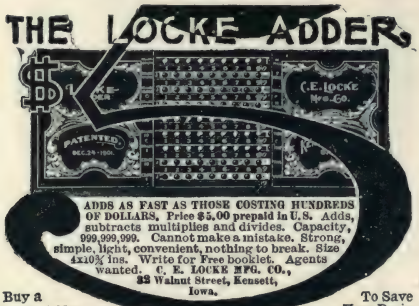

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CONSULTING DEPARTMENT—(Continued)

Water Pressure in Pipes

Question: Can you give me a short and accurate formula by which I can determine the pressure, per square inch, against which a steam pump has to work in the following cases?

(1) When length of line and vertical elevation are given;

(2) When length of line only is given, straight.

In neither instance is friction to be considered. —*J. L. B.*

Answer: Neglecting the friction of the water flowing in pipes, the only pressure to be overcome is that due to the static head. In Case 1, then, the only pressure is that due to the elevation. Knowing the elevation or head in feet, the pressure per square inch is found by multiplying the head in feet by .433. The only additional pressure required by the length of the pipe, is that due to the friction; and since you state that this is to be neglected, the pressure determined as above covers your question.

In Case 2, where the length of the line only is given, the pressure cannot be determined, since, as explained above, the only pressure would be that due to the friction of the water in the pipes. Neglecting the friction of the pump, but taking into consideration the friction of the pipes, the necessary steam pressure can be found in each case by adding the pressure due to the static head to the pressure required to overcome the friction in the pipes. The friction loss in pounds per square inch for each 100 feet of length is generally given in pump catalogues. You will find this friction loss to vary in any one size of pipe, about as the square of the velocity. Also the friction loss due to a given quantity of water flowing through a pipe, will be considerably less as the diameter of the pipe increases.

Carrying Power of Transformer

Question: If a transformer is rated at 500 watts at 1,000 volts primary, and 5 amperes at 50 volts secondary, or 10 amperes at 100 volts secondary, will this transformer carry 1,000 watts at 100 volts secondary?—*M. G. W.*

Answer: In the first place, you probably mean that the transformer supplies

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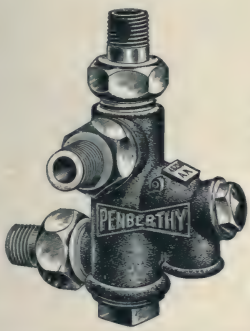

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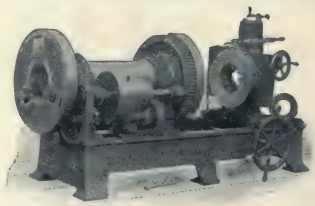

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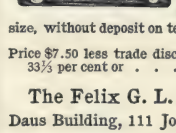

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CONSULTING DEPARTMENT—(Continued)

10 amperes at 50 volts secondary, or 5 amperes at 100 volts secondary, because, if it is a 500-watt transformer, the output should not exceed this amount. In order to obtain a secondary voltage of 100, you would need to double the primary voltage; and this would probably cause sufficient heating to destroy your transformer, which is not designed for such voltage. Moreover, you could not expect to obtain double the output for which the transformer was designed.

From the standpoint of copper, there would be no difficulty, as your current would be no greater than before; but if the flux paths of your transformer are designed for 500 watts and a definite primary and secondary voltage, you could not expect to double these factors, and it is evident that you could not reasonably hope to obtain 1,000 watts from your 500-watt piece of apparatus. If your secondary is wound in two sections, then, by connecting the two in series, you could obtain 5 amperes at 100 volts; and by connecting them in parallel, you could obtain 10 amperes at 50 volts. If your primary is wound in two sections normally giving 500 watts at 1,000 volts, you can impress 2,000 volts on the primary by putting the two primary sections in series.

Effect of Equalizer

Question 1: Two direct-current machines, one shunt-wound and one series-wound, are running in multiple. Does the equalizer affect the shunt in keeping them in balance?

Question 2: How does a machine get reversed with the equalizer in, when two machines are running in parallel?—*T. M.*

Answer 1: A series and a shunt machine could not be operated in parallel. The equalizer would do no good in this case in assisting the machines to keep at the same voltage. In fact, a series machine is in very unstable equilibrium when used in parallel operation, even with another series machine, unless special connections are made.

Answer 2: When two machines are running in parallel, if the voltage of one machine falls very decidedly for any

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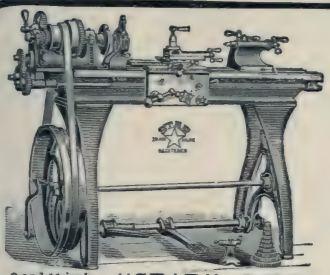

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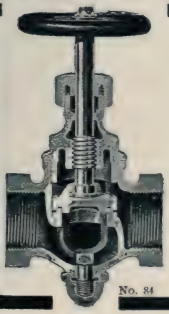

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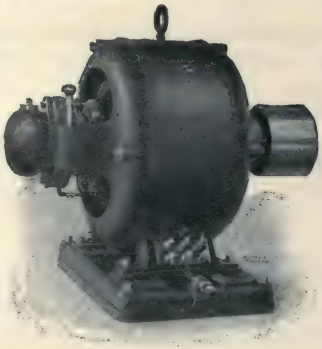

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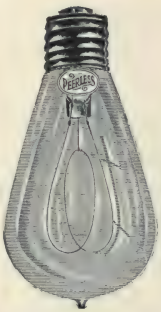

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CONSULTING DEPARTMENT—(Concluded)

reason—such as its prime mover slowing down or the loss of its shunt-field through an open circuit—then the other machine will send a current in the reverse direction through its series-coil, tending to run it as a motor. The first machine will then be required to run as a motor, driving its prime mover as a load, thus taking a heavy current through its series-coil, which may be sufficient to overcome the shunt magnetization, thereby reversing the field.

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'Tis strange how fashion makes us change the objects we admire;
We used to sing the tireless steed, but now the steedless tire.
So Otto bought an auto, so as not to be antique;
But the thing was autocratic, as well as automatic,
And the auto wouldn't auto as it ought to, so to speak.

He thought to hire an auto-operator for the work,
And first he hired a circusman, and then he hired a Turk,
For he knew the circusman drove fifty horses with success,
And if a man be shifty enough to manage fifty,
'Tis palpable enough he ought to manage one horse-less.

As for the Turk, 'tis also plain, deny it if you can,
He ought to run an auto, for a Turk's an Ottoman.
'Twas all in vain; so Otto moved to Alabama, purely,
That he might say: "I'm Otto from Mobile, and my motto:
'A Mobile Otto ought to run an automobile, surely!'"

So Otto fought the auto and the auto it fought Otto,
Till the auto also got too hot to auto as it ought to;
And then, Great Scott! that auto shot to heaven—so did Otto—
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Dixon, Wm. E., Northboro, Mass.—Course: Stationary.

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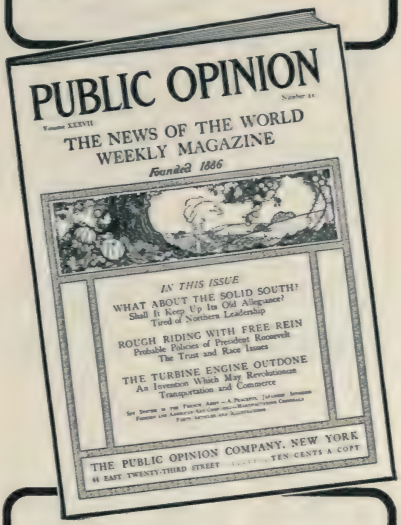
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Shall It Keep Up Its Old Allegiance?
Tired of Northern Leadership
ROUGH RIDING WITH FREE REIN
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An Error Corrected

THROUGH an error transcribed from the daily press, the name of Boyd Ehle, resident engineer with the Isthmian Canal Commission, was spelled "George Eberlee" in the reference made in our November number (p. 317) to the contemplated sea-level canal across the Panama divide. Mr. Ehle's discoveries affecting control of the Chagres river floods and the final solution of the waterway problem, were specially referred to by Chief Engineer Wallace in his speech before the Manufacturers' Association in Chicago.

Personal Notes

W. E. ATKINS, of East Weymouth, Mass., a student in the American School of Correspondence, in company with ten other men, one a naval officer, has been employed in inspection duty on the machinery of the new battleship *New Jersey*.

O. S. BICKFORD, of Greenfield, Mass., one of the foremen for Wells' Brothers Company, has just completed a course of instruction in the American School of Correspondence. This course, called the Mechanical-Electrical Engineer's course, includes over forty instruction papers—six being on mechanical drawing, which call for the making of over thirty drawing plates. This last part, Mr. Bickford finds to be of exceptional value in his work, as much of his time is spent in the designing of special machinery.

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JOE BEALL 'ud set upon a keg
Down to the groc'ry store, and throw
One leg right over t'other leg,
An' swear he'd never had no show.
"O, no," said Joe,
"Hain't hed no show!"
Then shif his quid to t'other jaw,
An' chaw, an' chaw, an' chaw, an' chaw.

He said he got no start in life,
Didn't get no money from his dad,
The washin' took in by his wife
Earned all the funds he ever had.
"O, no," said Joe,
"Hain't hed no show!"
An' then he'd look up at the clock,
An' talk, an' talk, an' talk, an' talk.

"I've waited twenty year—let's see—
Yes, twenty-four, an' never struck,
Altho' I've sot roun' patiently,
The fust tarnation streak er luck.
"O, no," said Joe,
"Hain't hed no show!"
Then stuck like mucilage to the spot,
An' sot, an' sot, an' sot, an' sot.

"I've come down regerler every day
For twenty years to Piper's store;
I've sot here in a patient way;
Say, hain't I, Piper?" Piper swore.
"I tell ye, Joe,
Yer hain't no show;
Yer too dern patient."—Ther hull raft
Jest laffed, an' laffed, an' laffed, an' laffed.

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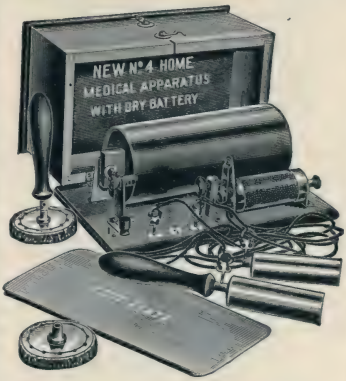

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Section 2 takes up various interesting discussions, such as effect of change of power factor on the voltage drop, relative weights of copper, etc., graphically illustrated. The principles of design and operation of alternating-current machinery are also treated. Another chapter is devoted to the transformer, while both the induction and repulsion motor are represented. Not the least valuable feature of the book is the treatment of the testing of alternating-current apparatus; and in general the book can be said to fill admirably the purpose for which it was intended by the author.

Elements of Mechanical Drawing. By Alpha Pierce Jamison, M. E., Assistant Professor of Mechanical Drawing at Purdue University. Cloth, Pages 226. Illustrated. John Wiley & Sons, Publishers, New York, N. Y. Price, $2.50.

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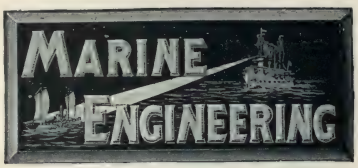

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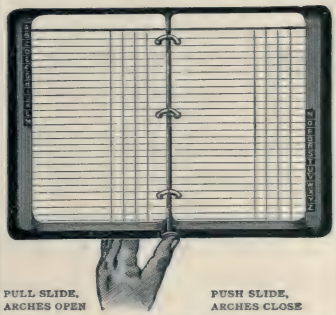

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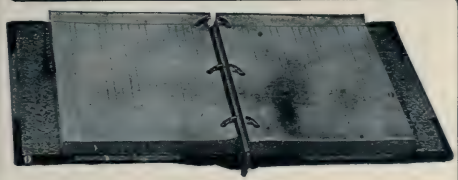

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Mechanical Appliances, Mechanical Movements, and Novelties of Construction. By Gardner D. Hiscox, M. E. Cloth. Pages 400. 970 Illustrations. Indexed. The Norman W. Henley Publishing Company, New York, N. Y. Price, $3.00.

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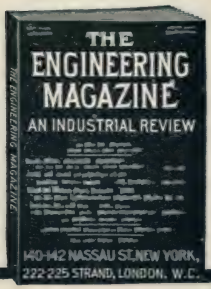

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Accidents and Emergencies. By Charles W. Dulles. M. D. 6th Edition, Revised and Enlarged, with New Illustrations. Cloth. Pages 209. Indexed. P. Blakiston's Sons & Company, Publishers, Philadelphia, Pa. Price, $1.00 net.

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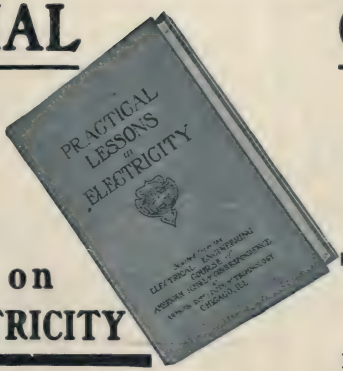

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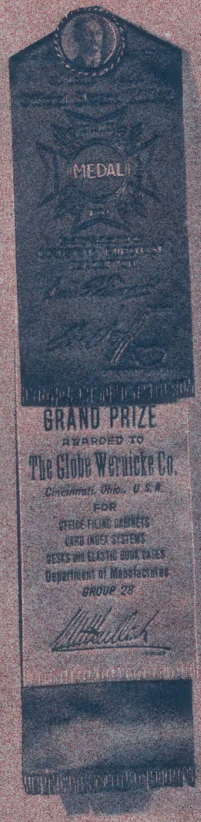

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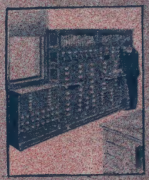

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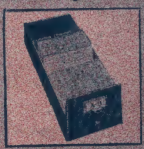

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